LOOKING FROM THE OUTSIDE IN: A SPATIAL ANALYSIS OF

STUDENTS' NEIGHBORHOOD CHARACTERISTICS AND

SCHOOL PERFORMANCE IN PHILADELPHIA

by

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Abstract. Access to a quality education is unevenly mapped by the demographic context of the communities in which public school students live. A growing body of research suggests that this geographic effect deeply challenges the goal of equalizing educational opportunities. This paper explores the relationship between students' neighborhood characteristics and school performance in Philadelphia's public schools using spatial analysis methods. Data include student and school locations as well as block-level census information and Pennsylvania System of School Assessment (PSSA) scores for grades 5, 8, and 11 during 2005-2008. Multiple regression and K-function analyses in conjunction with geographic information systems (GIS) were employed to test hypotheses linking students' community attributes to their schools' academic performance. Characteristics of students' neighborhoods, such as the percentage of the population holding a 4-year college degree and the proportion of families with a female head of household, were found to be strong predictors of school performance. Across all nine datasets, the geographic diversity of the student population was positively associated with school performance. In most cases, significant clustering was detected among schools reporting scores at or below the first quartile, and the locations of the lowest- and highest-performing schools were discovered to be spatially dependent. A range of policy implications is offered. Presented at the 2010 ESRI Education User Conference in San Diego, California, July 11, 2010.

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At this time, the accountability movement has given little attention to how much socioeconomic context influences educational outcomes. Furthermore, there is almost no recognition in the research literature that socioeconomic factors are spatially distributed and thus can be subjected to geographic analysis.

Pitts & Reeves, 1999, p. 2

Introduction. Access to a quality education is unevenly mapped by the demographic context of the communities in which public school students live. A growing body of research suggests that this geographic effect deeply challenges the goal of equalizing educational opportunities. The plight of countless failing schools is not a self-contained problem uninfluenced by sociological forces, including poverty and residential segregation. According to Harvard sociologist William J. Wilson (2009), author of *More than just race: Being black and poor in the inner city*, "[L]iving in a ghetto neighborhood has both structural and cultural effects that compromise life chances above and beyond personal attributes" (p. 47).

Over the decades, a bevy of reform efforts, both programmatic and systemic, have been implemented with the aim to narrow the pernicious achievement gap between lower-income minority students and higher-income majority students. One approach that has received increasing attention in recent years is socioeconomic integration, which proposes that mixing heterogeneous student populations will enhance the achievement of children living in marginalized communities. The study documented in this paper highlights this claim but primarily uses spatial analysis methods to explore the relationship between Philadelphia students' neighborhood characteristics and the performance of the traditional and charter schools that they attend. The following questions are addressed using student and school locations, Pennsylvania System of School Assessment (PSSA) scores, and United States Census 2000 data:

1) Are students' neighborhood characteristics good predictors of how Philadelphia schools perform?
   a) Can it be inferred that there is a direct relationship between the socioeconomic condition of students' communities and the academic performance of their schools?

b) How much variation in school performance can be attributed to neighborhood effects?

2) What does the distribution of the lowest- and highest-performing schools look like across the city?

a) Specifically, are there clusters or what appear to be random patterns?

b) What does the spatial distribution of these schools suggest about educational opportunity in Philadelphia?

Literature Review

In "Spatial Analysis of Contextual Effects on Educational Accountability in Kentucky," Pitts and Reeves (1999) explored the influences of a variety of district-level variables on school performance. According to them, research has begun to suggest that socioeconomic (SES) factors associated with geographic location have a strong determining influence on school system performance and, therefore, accountability test results. Through their spatial analysis of Kentucky education data, they found that the largest effect on a district's accountability score was the percentage of students on free or reduced-price lunch (FRL). Similarly, Bourke (1998) looked at the relationship between the poverty of the schools in a South Carolina school district, as measured by the schools' proportion of FRL students, and grade 5 standardized test scores, and concluded that percent FRL and other school-level variables were as powerful for predicting individual student achievement as similar student-level variables. These studies provide evidence that factors over which public schools generally have little control, such as the poverty of their students, may heavily influence educational outcomes. Pitts and Reeves have argued that a more just accountability system would incorporate SES factors into the assessment of schools.

Several other studies examining neighborhood effects on student achievement have revealed the importance of acknowledging contextually-driven sociological forces when contemplating education policy solutions (Sampson, Sharkey, & Raudenbush, 2008; Tate, 2008; Israel, Beaulieu, & Hartless, 2001; Baker, McGee, Mitchell, & Stiff, 2000; Shumow, Vandell, & Posner, 1999; Lippman, Burns, & McArthur, 1996; Yancey & Saporito, 1995). For example, Sampson et al. (2008) investigated the enduring effects of concentrated poverty on black

children's verbal ability. They studied a representative sample of 750 African-American children, ages six to twelve, who were growing up in the city of Chicago during the 1990s. The study provided evidence that "residing in a severely disadvantaged neighborhood cumulatively impedes the development of academically relevant verbal ability in children" (p. 2). Moreover, using data from several national studies, Lippman et al. (1996) compared urban students and schools with their suburban and rural counterparts on a broad range of factors, including student outcomes. Among several findings, the researchers discovered that, especially at younger ages, "Urban students and schools compared less favorably to their non-urban counterparts on many measures even after accounting for the high concentration of low-income students in urban schools" (p. xi).

This latter study in particular implies that economic disparities alone do not explain the achievement gap between students living in different regions. Children are also influenced by "social-psychological dynamics" (Conley, 1999, p. 126), such as future expectations, at home and in their neighborhoods. Theories on social capital, in large part developed by Robert Putnam and James Coleman, suggest that cultural behavior learned and perpetuated within communities deeply impacts the economic organization and civic engagement of a local population (Shirley, 1997). Put a different way, norms practiced among particular social groups contribute to enduring socioeconomic inequalities. Allison Davis (1949), an advocate of "culture-free" testing, discussed social class as a dispenser of cultural learning that shapes a child's learning environment. To address the exposure gap between disadvantaged and privileged youth, James Comer (2002) has asserted that providing mainstream experiences to low-income students in their schools is crucial to their developmental growth. He has emphasized that children are better positioned to thrive in school when their families and communities bolster their academic and social development through capitalizing on everyday teachable moments and leading them by example. Similarly, Shumow et al. (1999) pointed out, "Central to the study of neighborhoods is the notion that the aggregate of individuals and families within a neighborhood setting creates a context that influences child development" (p. 1). The ability for a community to reach a common goal, such as improving student outcomes, can be formalized as "civic capacity," which rests on relationships characterized by "shared understandings, feelings of trust and mutuality,

and a pragmatic orientation toward give and take" (Stone, Henig, Jones, & Pierannunzi, 2001, p. 167).

For decades researchers have acknowledged the complexity of identifying influences on student outcomes and the challenge this presents to the goal of equalizing educational opportunities. In the mid-1960s, the racial achievement gap was critically evaluated for a report commissioned by the U.S. Congress. *Equality of Educational Opportunity*, also known as the "Coleman Report" for principal author James Coleman, concluded that school-based differences could not fully explain the disparity in educational achievement between blacks and whites. Instead, it asserted that "for all racial groups, family background (that is, class) mattered much more than school policies (such as curriculum, teacher-to-pupil ratios, and so on) in determining the success or failure of students" (Conley, 1999, pp. 55-56). The socioeconomic achievement gap is evident as soon as students begin school and is easily sustained when high concentrations of economically disadvantaged students attend school together (Bazelon, 2008; Betts, Zau, & Rice, 2003). Since the Coleman Report was released, many scholars have analyzed it and drawn the same basic conclusion—that the American education system helps maintain the status quo by "reproducing the same class differences that children brought to it in the first place" (Conley, 1999, p. 56; Anderson, 2004).

The right to receive to a quality education was extended to racial minorities with the U.S. Supreme Court's landmark 1954 civil rights ruling, *Brown v. Board of Education*, quelling *de jure* racial segregation in American school systems. However in 2007, the Court deemed race-based integration unconstitutional and decided to prohibit the Seattle, Washington and Louisville, Kentucky public school districts from using race as a determining factor for assigning students to their schools. This led Louisville and later four other districts (Des Moines, IA; Burlington, VT; Omaha and Beaumont, TX) to announce a switch to class-based integration. Emily Bazelon (2008) described this practice in the article "The Next Kind of Integration." The powerful effect of the socioeconomic composition of a student body on academic achievement has become "one of the most consistent findings in research on education," asserted Orfield and Eaton in *Dismantling Desegregation* (quoted in Bazelon, 2008, p. 3). Furthermore, as economist Ronald Ferguson has pointed out, to really benefit from integration, poor students have to be

evenly distributed among classrooms rather than being grouped together in the lowest tracks (Bazelon, 2008).

Bazelon also discussed a spatial analysis done for the Louisville, Kentucky district in which analysts used geographic information systems (GIS) to map areas where median household income and educational attainment were lower than average and the minority population higher than average. The potential application of their analysis was to assign students to schools with attention to socioeconomic and, indirectly, racial diversity. One major limitation to this type of integration is that it rests on the assumption that communities with different socioeconomic characteristics are located adjacent to one another. The ability to integrate this way is contingent on the communities involved.

The purpose of this study was not to abdicate the inner workings of a school that unequivocally impact student achievement but rather to explore the factors beyond a school's reach. The success of a variety of initiatives has suggested that schools, regardless of their demographic contexts, are capable of yielding optimal student outcomes. The Promise Academy Charter School, for example, is a key component of the Harlem Children's Zone (HCZ) and reflective of a programmatic reform effort to improve the outcomes of students at risk for academic failure (HCZ, 2009a). Recently, the results of a longitudinal study evaluating the effectiveness of the Promise Academy were reported by economist Roland Fryer, who looked at a cohort of 8th grade students who had entered the school performing well below the city average on a math and English language arts assessment. He found that in math, the Promise Academy students surpassed the city average for white students (Brooks, 2009). At the same time, perhaps it should be acknowledged that the Promise Academy is not a standalone intervention. The HCZ is based on a *holistic* system of wraparound support services (e.g., social, health) aimed at helping the children and families within a specific region.

In addition, existing research has found that numerous school-level factors influence student outcomes, including teacher effectiveness (Stronge, Ward, Tucker, & Hindman, 2007; Betts et al., 2003; Goldhaber & Anthony, 2003), principal leadership (Hallinger & Heck, 1996), curriculum (Martin, 2006; Alexander, 2000), and school climate (Uline & Tschannen-Moran,

2008; Sweetland & Hoy, 2000). There are also student-level characteristics that leverage learning (Stewart, 2008), such as a child's interest in a subject and the challenge of being an English language learner. Moreover, some possible influences on school performance are difficult to measure quantitatively. Scholars and practitioners in the education community have not reached consensus on the extent to which several of these variables are important. Many would agree, however, that both school- and student-level factors are often dynamically linked to students' neighborhood characteristics. While the focus of this study is on neighborhood factors, the author maintains that it is the delicate interaction of multiple factors that impact student achievement.

Data and Preliminary Analyses

This study was based on students in grades 5, 8, and 11 attending traditional and charter schools throughout Philadelphia County during the 2005-2008 school years.[1] Figure 1 displays the geographic distribution of the schools included in the data. With an enrollment of over 190,000 students attending more than 300 schools (SDP, 2009a), the School District of Philadelphia (SDP) was cited as the tenth largest in the nation in 2006 (National Center for Education Statistics, 2009). At 32.2%, it had the highest poverty rate of 5- to 17-year-olds among these ten urban districts (NCES, 2009). In 2002, the SDP was taken over by the state of Pennsylvania, an action prompted by the No Child Left Behind (NCLB) legislation of 2001 intended to overhaul practices contributing to persistent low achievement (Gill, Zimmer, Christman, & Blanc, 2007).

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[1] Disciplinary and accelerated schools were excluded.
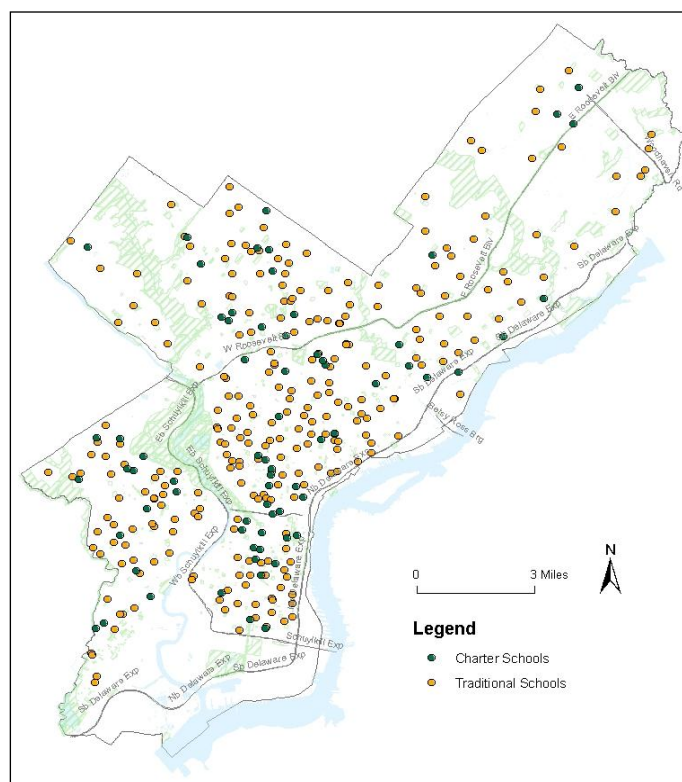
Fig. 1: Philadelphia Traditional & Charter Schools

For all statistical analyses in this study, school grade groups were the unit of analysis. The dependent variable was *Composite PSSA Score* (*CPS*), the sum of a school's percentages of students scoring proficient or advanced in reading and math. The PSSA is a standardized assessment of student achievement that is administered in select grades across the state of Pennsylvania each spring. Data were retrieved from the Pennsylvania Department of Education for three consecutive school years between 2005 and 2008, totaling 9 datasets.

Eleven independent variables were created using individual students' census block-group data averaged for the 5th-, 8th-, and/or 11th-grade groups at each school. The purpose of using census data was to extract salient neighborhood characteristics and to determine which, if any, were strongly associated with school performance. Defining a "neighborhood" can be quite problematic (Cartographic Modeling Lab, 2009), yet for the statistical analyses a neighborhood is simply represented as the geographic entity of the block group in which a student lived. For easy reference, in this report specific Philadelphia neighborhoods will not be identified but rather general regions of the city. The manner in which independent variables were chosen was largely

exploratory. See Appendix A for a full description of the variables, including rationales for their use in the study.

Before performing the analyses, observations were made about the dependent variable, *Composite PSSA Score*. There was a steady increase in school performance during 2005-2008 across all grades in the study. The characteristics of the PSSA datasets are provided in Table 1 below:

Grade	Count of Schools (N)	Mean	Standard Deviation	Minimum	Maximum	Quartile 1	Quartile 3
2005-06							
5	195	75.7	40.5	11.6	200.0	40.6	100.0
8	135	87.6	41.6	18.9	200.0	55.3	112.5
11	56	59.2	52.9	0.0	197.1	24.9	83.4
2006-07							
5	206	77.0	41.2	10.6	198.8	42.8	101.6
8	147	99.5	39.6	25.7	200.0	69.3	126.2
11	63	67.4	50.6	3.0	196.6	28.4	95.6
2007-08							
5	211	86.7	41.0	6.3	200.0	55.4	113.4
8	160	110.3	38.3	32.4	200.0	80.1	139.8
11	73	72.6	48.6	9.1	199.1	34.7	101.5

Table 1: Summary Statistics for *Composite PSSA Score*

The distribution of the dependent variable for grades 5 and 8 during all years was generally normal. The slight skew toward the right, with examples shown in Figures 2 and 3, signifies that high performance on the PSSA exam has been relatively atypical.
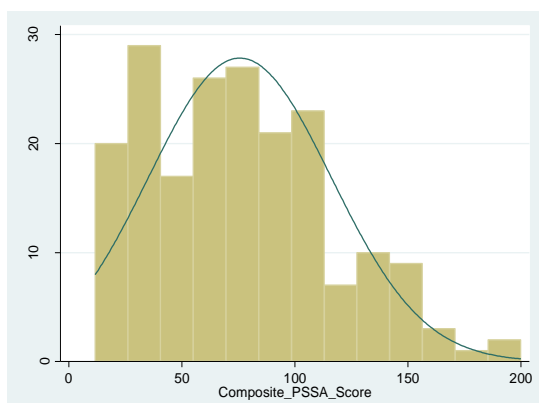
Fig. 2: Frequency Distribution of *CPS*, Gr. 5, 2005-06
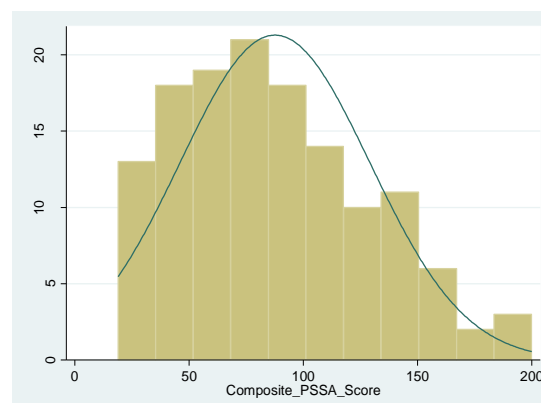
Fig. 3: Frequency Distribution of *CPS*, Gr. 8, 2005-06

The extreme positive skew of grade 11 *CPS* suggests that meeting state standards has been more elusive for the upper grades (see Figure 4). A logarithmic transformation was taken for each of the grade 11 datasets, and Figure 5 provides an example of this based on the 2005-06 school year.[2]
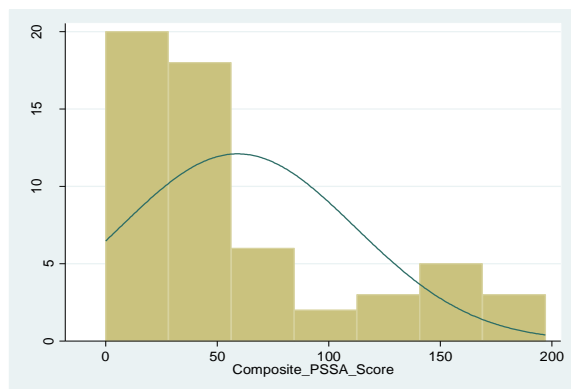
Fig. 4: Frequency Distribution of *CPS*, Gr. 11, 2005-06
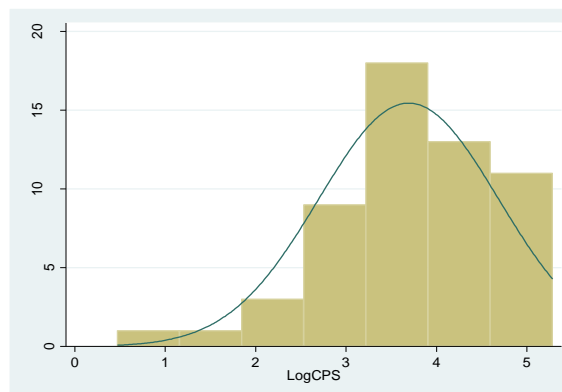
Fig. 5: Frequency Distribution of *LogCPS*, Gr. 11, 2005-06

Neighborhood variables that strongly correlate with *Composite PSSA Score* may impact student achievement. Table 2 provides the correlation of *CPS* with each independent variable. Note that the direction and strength of each factor were very similar across grades and years. Neighborhood characteristics evincing socioeconomic challenges and large minority populations were negatively, and moderately, associated with *CPS* (see *).

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[2] The log distribution is a variance-stabilizing transformation that corrects skewness so that the data meet basic assumptions concerning regression analysis (Bailey & Gatrell, 1995). In the Multiple Regression section of this report, *CPS* for 11th grade refers to *LogCPS*.

Neighborhood Variable	Correlation with *CPS*		
	2005-06	**2006-07**	**2007-08**
Average % of Households with	-0.5527 (*5*)	-0.5015 (*5*)	-0.5441 (*5*)
Female Head of Household with	-0.4768 (*8*)	-0.5710 (*8*)	-0.5140 (*8*)
Related Children under 18*	-0.4451 (*11*)	-0.4515 (*11*)	-0.4755 (*11*)
Average % of Population Holding	0.4594 (*5*)	0.4281 (*5*)	0.4618 (*5*)
Bachelor's or More Advanced	0.5203 (*8*)	0.5370 (*8*)	0.4391 (*8*)
Degree	0.5727 (*11*)	0.5008 (*11*)	0.5217 (*11*)
Average Median Household	0.4860 (*5*)	0.4748 (*5*)	0.5518 (*5*)
Income	0.4990 (*8*)	0.5381 (*8*)	0.4821 (*8*)
	0.4410 (*11*)	0.4127 (*11*)	0.4557 (*11*)
Average % of Families below	-0.4388 (*5*)	-0.4295 (*5*)	-0.5042 (*5*)
Poverty Level*	-0.4822 (*8*)	-0.5042 (*8*)	-0.4713 (*8*)
	-0.4199 (*11*)	-0.4092 (*11*)	-0.4410 (*11*)
Average % of Population	-0.5001 (*5*)	-0.4635 (*5*)	-0.5139 (*5*)
Unemployed*	-0.4964 (*8*)	-0.5364 (*8*)	-0.4668 (*8*)
	-0.4297 (*11*)	-0.3768 (*11*)	-0.4333 (*11*)
Average % of Population under	-0.4812 (*5*)	-0.4608 (*5*)	-0.4731 (*5*)
Age 25*	-0.4653 (*8*)	-0.4677 (*8*)	-0.4702 (*8*)
	-0.5356 (*11*)	-0.5027 (*11*)	-0.5100 (*11*)
Average % of Population Non-	-0.4408 (*5*)	-0.4073 (*5*)	-0.4524 (*5*)
White or Non-Asian*	-0.3874 (*8*)	-0.4639 (*8*)	-0.4365 (*8*)
	-0.2462 (*11*)	-0.2861 (*11*)	-0.3182 (*11*)
Average % of Population Non-	-0.4375 (*5*)	-0.4101 (*5*)	-0.4579 (*5*)
White*	-0.3694 (*8*)	-0.4555 (*8*)	-0.4294 (*8*)
	-0.2382 (*11*)	-0.2826 (*11*)	-0.3058 (*11*)
Average %of Population Not in	-0.3600 (*5*)	-0.3284 (*5*)	-0.4365 (*5*)
Labor Force*	-0.4754 (*8*)	-0.4463 (*8*)	-0.3831 (*8*)
	-0.3356 (*11*)	-0.3263 (*11*)	-0.3703 (*11*)
Average Total Population	0.2556 (*5*)	0.2511 (*5*)	0.2738 (*5*)
	0.1992 (*8*)	0.2502 (*8*)	0.2779 (*8*)
	0.2375 (*11*)	0.2748 (*11*)	0.2562 (*11*)
Average % of Population Holding	-0.0436 (*5*)	-0.0392 (*5*)	0.0370 (*5*)
High School Diploma or	-0.0596 (*8*)	-0.0804 (*8*)	0.0037 (*8*)
Equivalency Only	-0.1878 (*11*)	-0.0382 (*11*)	0.0416 (*11*)

*Negatively and moderately associated with *CPS*

Table 2: Correlation (Pearson's *r*) with the Dependent Variable

Methods and Analyses. The analytic methods that follow were used for exploring relationships between school performance and students' neighborhood characteristics. The first section provides a visual analysis to later be compared with the statistical analyses. Next is a multiple regression analysis, and the study concludes with a Cross K-function analysis to determine the spatial orientation of the lowest- and highest-performing schools.

Visual Analysis

A visual examination of the data provides insight for hypothesizing relationships among the variables and possibly generating support for the statistical analyses that follow. This type of analysis enables one to examine which factors may reinforce each other rather than work independently. Figure 6 reveals the spatial distribution of the lowest- and highest-performing elementary schools in Philadelphia based on *CPS* quartiles for grade 5 during the 2007-08 school year. The pattern on this map was generally consistent across grades 5 and 8 for all years in the study. The top schools appeared to be more scattered throughout the region than the bottom schools, the latter of

Fig. 6: Lowest- and Highest-Performing Schools, Gr. 5, 2007-08, with SDP Regions

which were found in a diagonal band stretching from the upper eastern to lower western sections of the city. This trend was not apparent for high schools where, except for a vertical strip of top schools that were most prominent during the 2005-06 and 2006-07 school years, the lowest- and highest-performing schools appeared to be generally scattered. See Figures 1-9 in Appendix B for maps showing the two point patterns for each dataset.

The maps in Figures 7 through 10 assist with visualizing relationships between school performance and the characteristics of the neighborhoods where they are located.[3] This analysis is most useful for investigating schools in which the student population comes primarily from the school's surrounding neighborhood. This is the case for traditional elementary schools and neighborhood high schools, which draw their students predominantly from conterminous catchment areas. In contrast, charter schools and the SDP's selective high schools do not have catchment areas, and the locations of enrolled students are therefore usually much less clustered.

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[3] White areas represent unreported census data.

See Figures 1 and 2 of Appendix C for examples of clustered and non-clustered student distributions. By the 2008-09 school year, charter schools accounted for about 20% of all Philadelphia public schools, and almost 40% of high schools were selective. For the regression analysis, the neighborhood characteristics were averaged for each school according to *student* locations, which are not necessarily reflective of the school's surrounding community. The relationships between the independent variables and school performance may therefore be stronger than the geographic images illustrate.
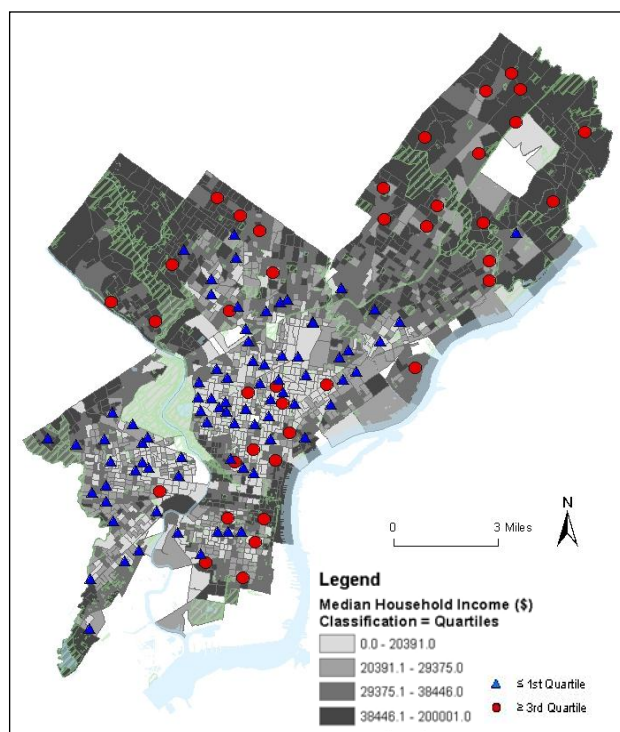
Fig. 7: Overlay of Lowest- & Highest-Performing Schools, Gr. 5, 2007-08, with Median Household Income by Block Group
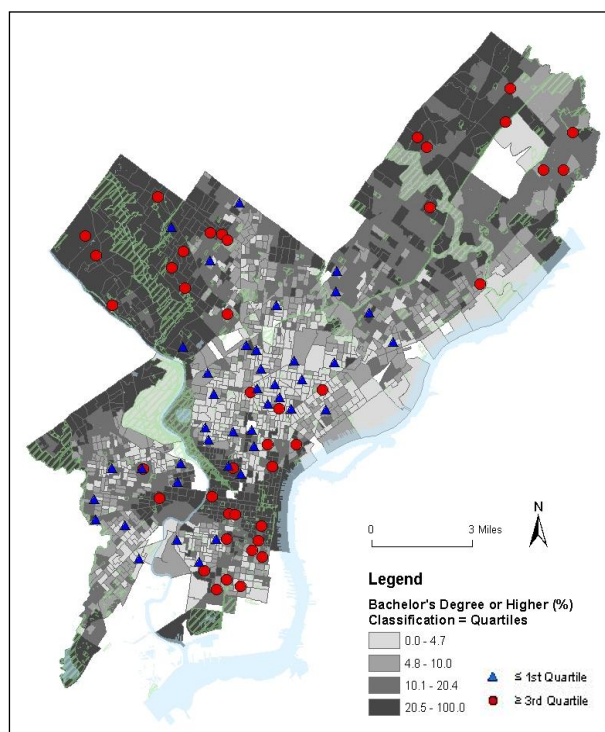
Fig. 8: Overlay of Lowest- & Highest-Performing Schools, Gr. 8, 2007-08, with % of Population Holding Bachelor's or More Advanced Degree by Block Group

The visual representations of the census data shown in these maps provide insight about spatially autocorrelated phenomena in Philadelphia County. Spatial autocorrelation (SAC) "involves the correlation between values of the same variable at different spatial locations" (Bailey & Catrell, 1995, p. 269). When SAC is present, there is a high probability of similarity between two values, or features, due to their proximity to one another. Increasing distance between two features reduces their similarity (Smith, 2009). In Figures 7 and 8, there appear to be "hot spots,"

geographic areas in which similar values are concentrated. For example, in Figure 7 low median household incomes were reported for much of North, West, and Southwest Philadelphia, whereas income was higher in the Southeast (Center City and South Philadelphia), the Northwest, and the Northeast. While the highest-performing schools were dispersed throughout most of the city, many of the lowest-performing schools were found concentrated in the poorest areas.

Figure 8 suggests that *CPS* may also relate to the percentage of residents holding a bachelor's or more advanced degree. North, West, and Southwest Philadelphia yielded small percentages of college-educated residents, as well as many struggling schools. The block group data revealed that residents' education levels were spatially related since similar values were often in close proximity to one another. Note that Figures 7 and 8 also provide a basis for comparing the two demographic characteristics. The overall color patterns align well, and it was determined that, across datasets, median household income and education level were strongly correlated at about *r*=0.70.
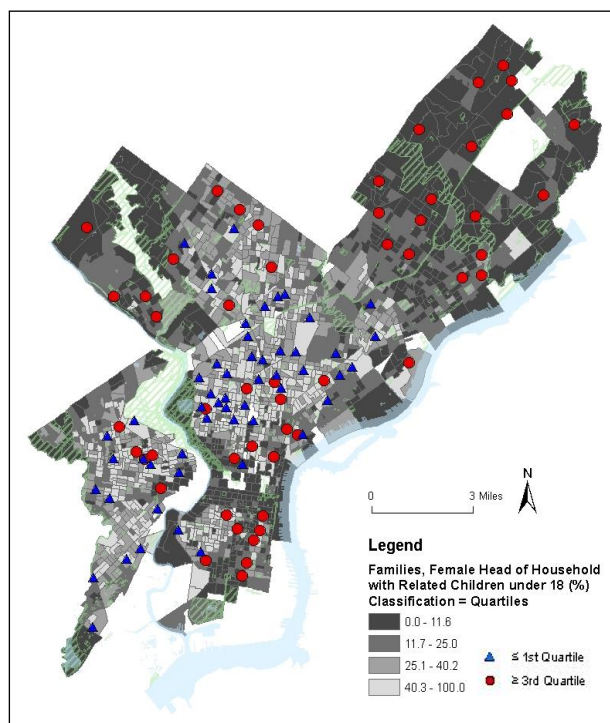
Fig. 9: Overlay of Lowest- and Highest-Performing Schools, Gr. 5, 2006-07, with % of Families with Female Head of Household with Related Children under 18 by Block Group
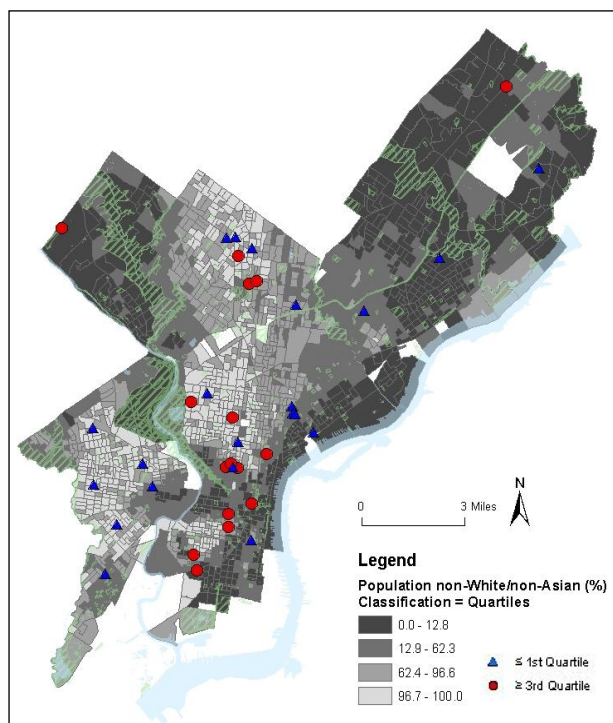
Fig. 10: Overlay of Lowest- and Highest-Performing Schools, Gr. 11, 2005-06, with % of Population Non-White/Non-Asian by Block Group

For Figures 9 and 10, the color ramp for the variable was flipped to be consistent with the previous two maps in terms of the hypothesized correlation with school performance. Figure 9 shows a concentration of families in the North, West, and Southwest regions of the city where at least one in four families consisted of a female head of household with related children under 18 years of age. Moreover, the speckles of the lightest tone of gray in these same regions indicate where the percentage of families of this type was at 40 percent and higher. Southeast, Northwest, and Northeast Philadelphia reported much lower levels of this demographic and yielded many of the highest-performing schools. Overall, the mass of this neighborhood characteristic dissipated outwards in a way that was inversely related to income and educational attainment.

In contrast to the map in Figure 9, the color pattern in Figure 10 is much more clumped, exhibiting relatively dramatic shifts in the racial composition of one region to the next. This map reveals a similar color pattern as those presented in Figures 7 through 9. In other words, sections of the city where the non-white/non-Asian population was especially high often corresponded with relatively high rates of female-headed households and low levels of income and educational attainment. These sections were identified as the North, West, and Southwest sections of the city. Several struggling high schools from 2005-06 were located in these areas, but this was also the case for the highest-achieving schools, implying that there may not be a strong link between a neighborhood's racial composition and *CPS*. However, as noted above, charter high schools and selective high schools, which make up Philadelphia's tiered system of secondary schools, do not have catchment areas and in many cases draw their students from all across the city. This likely weakens the relationship between a school's performance and the demographic characteristics of its surrounding neighborhood. For more information, see *School Type* in Appendix A.

The maps discussed in this section also provide information on the distribution of the neighborhood variables. The household income and education level data in Figures 7 and 8 are noticeably right-skewed since high values are infrequent, often corresponding with block groups that are large in area up north or concentrated in the central part of the city. On the other hand, the female-headed households data in Figure 9 appear more evenly distributed, and racial composition in Figure 10 appears to have a bi-modal nature. This latter phenomenon can be interpreted as an effect of residential segregation in which numerous block groups have low

percentages of minorities while others have very high proportions. Put a different way, it has been rather atypical for a Philadelphia neighborhood to be racially balanced. See Appendix C for the frequency distribution of each demographic characteristic discussed here, as well as maps for the remaining census data. The above visual observations suggest that these neighborhood characteristics—averaged by school based on individual student data—would likely be significant predictors of *Composite PSSA Score* in the regression models.

Multiple Regression Analysis

Ordinary Least Squares (OLS) multiple regression was performed on the data to determine whether or not students' neighborhood characteristics could serve as strong predictors of school performance. Three school-based explanatory variables were also included: *Enrollment*, *Geographic Diversity*, and *School Type*. For the 2007-08 school year, a few additional school-based variables were used for exploratory purposes: *% English Language Learners*, *% Receiving Free or Reduced-Price Lunch,* and *% Receiving Special Education Services*.[4] Information on these and all variables is found in Appendix A. As stated in the Introduction section, there are many school characteristics to account for, some of which are difficult to quantify—teacher effectiveness, for example. The inability to account for major influences on student achievement, due to the unavailability and/or inaccessibility of such attributes, limits the analysis findings. Another limitation of this analysis is the exclusion of substantial school-based variables, which could control for neighborhood effects, in the multiple regression models. Despite these shortcomings, the OLS analyses provide insights concerning the interaction between contextual factors and school performance in Philadelphia.

Because of the number of independent variables involved, a stepwise regression was employed in the JMP statistical program, which allows one to construct the best model, given the data, for predicting the dependent variable through successive addition of the most significant explanatory variables. Prior to this step, however, the regression results were assessed for each independent

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[4] "School-based" variables may also be considered "contextual" factors impacting school performance since they vary according to school. What differentiates them from "neighborhood" variables is that they are derived from school data instead of census data.

variable. Results for grade 5 in 2007-08 are provided in Table 3. The unstandardized coefficient estimates and *p*-values for all datasets can be found in Tables 1 and 2 of Appendix B.[5] There were no major deviations from the overall pattern given here in magnitude, sign, and *p*-value for each explanatory variable across grades and years. In several cases, however, neighborhood effects appeared to be less influential for high school *CPS*. For example, racial composition and families living in poverty were noticeably weaker predictors of *CPS* for grade 11 than for grades 5 and 8.

	R^2	Unstandardized Coefficient (β)
Neighborhood Variables		
AvgMedHshdInc	0.3045	0.0026***
Avg%FemHshdKids<18	0.2961	-1.8602***
Avg%PopUnemployed	0.2640	-3.3752***
Avg%Famlies<Poverty	0.2543	-1.6012***
Avg%Pop<Age25	0.2238	-3.3180***
Avg%PopBachDeg≥	0.2133	2.5569***
Avg%PopNonWhite	0.2097	-0.6439***
Avg%PopNonWhAs	0.2047	-0.6069***
Avg%PopNonLaborForce	0.1906	-2.5262***
AvgPop	0.0750	0.0337***
Avg%PopHSDiploma	0.0014	0.3052
School Variables		
%FRL	0.4269	-1.6633***
GeographicDiversity	0.0442	34.4987***
%SpecialEd	0.0406	-1.5916***
SchoolType	0.0037	6.7134
%ELL	0.0028	-0.2622
Enrollment	0.0024	0.0579

*p<0.10, **p<0.05, ***p<0.01

Table 3: Regression Results of Each Explanatory Variable, Gr. 5, 2007-08

The null hypothesis for this analysis was that none of the independent variables derived from students' community attributes were strong predictors of *Composite PSSA Score*. Based on the results in Table 3, the null hypothesis could be rejected in almost every case for the neighborhood variables. Three of the school variables were also significant predictors of *CPS*. The percentage of students receiving free or reduced-price lunch (*%FRL*) individually accounted for almost 43% of the variation in the dependent variable—more than any other significant predictor. Similarly, the percentage of students receiving special education services (*%SpecialEd*) yielded a small *p*-value and was negatively associated with school performance.

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[5] Table 2 above provides the standardized coefficients of the neighborhood variables, in which the unit of measurement is standard deviations of *CPS*.

However, the percentage of students speaking English as a second language (*%ELL*) was a weak predictor, especially for grade 5. In none of the nine datasets was *Student Enrollment* or *School Type* a significant explanatory factor. On the contrary, *Geographic Diversity* generated a small *p*-value in every case as well as a positive estimate, indicating that there was a direct relationship between school performance and the geographic variety of students' neighborhoods.

Based on all datasets, the most pervasive variables resulting from the step-wise regression included, in descending order, *Average % of Population with Bachelor's or More Advanced Degree*, *Average % of Families with Female Head of Household with Related Children under 18*, and *Average % of Population Non-White and Non-Asian*. The R-Square value reporting how well predicted values matched observed values ranged from 0.19 to 0.36. Table 4 lists the explanatory variables included in the linear models for each dataset. Because of multi-collinearity, some independent variables lost significance during the stepwise regression. For example, *Average Median Household Income* and *Average % of Families with Female Head of Household with Related Children under 18* were often correlated at values of -0.80 and stronger. For this reason, the two variables were not found together in any model.

Grade	R^2	Avg%Pop BachDeg≥	Avg%Fem HshdKids<18	AvgMedHshd Inc	Avg%Pop NonWhAs	Avg%PopNon LaborForce	Avg%Pop <Age25
2005-06							
5	0.35	1.3317***	-1.6321***				
8	0.35	1.8382***			-0.3816***	-1.1441*	
11	0.30	0.0940***			-0.0087*		
2006-07							
5	0.28	1.1831***	-1.3289***				
8	0.39	1.7598***	-1.3975***				
11	0.19						-0.0949***
2007-08							
5	0.36	1.0476**		0.0014***	-0.3032***		
8	0.29	1.0901***	-1.3455***				
11	0.29	0.0407*	-0.0291**				

*p<0.10, **p<0.05, ***p<0.01

Table 4: Results of All Step-wise Multiple Regression Models

Again using the grade 5, 2007-08, example, from the stepwise regression process using only neighborhood variables with a *p*-value limit of 0.10, the following linear model was estimated:

$$CompositePSSAScore_i = \beta_0 + \beta_1\, AvgMedHshdInc_i + \beta_2\, Avg\%PopBachDeg\geq_i - \beta_3\, Avg\%PopNonWhAs_i + \varepsilon_i,$$
$$i = 1,\ldots, 211$$

The R-Square for the model indicated that only about 36% of the variation in *CPS* could be explained by the three independent variables. Note that the signs of the coefficients are as hypothesized: positive for *Average Median Household Income* and *Average % of Population Holding Bachelor's or More Advanced Degree*, negative for *Average % of Population Non-White and Non-Asian* (see Table 5). All other neighborhood-based explanatory variables lost significance with this combination.

Parameter Estimates					Summary of Fit	
Term	β	Std Error	t Ratio	Prob>|t|	R^2	0.3562
Intercept	55.1889	13.5407	4.08	<0.0001	R^2 Adj	0.3469
AvgMedHshdInc	0.0014	0.0004	3.56	0.0005	Root Mean Square Error	33.1427
Avg%PopBachDeg≥	1.0476	0.4139	2.53	0.0121	Mean of Response	86.6517
Avg%PopNonWhAs	-0.3032	0.0898	-3.38	0.0009	Observations	211

Table 5: Detailed Results of Stepwise Regression Model, Gr. 5, 2007-08

Viewing and mapping the standardized residuals from the regression analysis enables one to identify schools in which student performance is as expected, greater than expected, and less than expected—net of the children's community factors. Continuing with the grade 5, 2007-08, example, the linear regression model was based on the three explanatory variables shown in Table 5. The residuals resulting from the OLS regression were plotted against the predicted values as shown in Figure 11. The linear model for grade 5, 2007-08, produced standardized residuals depicting random noise, and this pattern indicates that the residuals are independently and normally distributed. In other words, there appear to be little or no spatial dependencies remaining in the data, suggesting that the model is a good fit.[6]
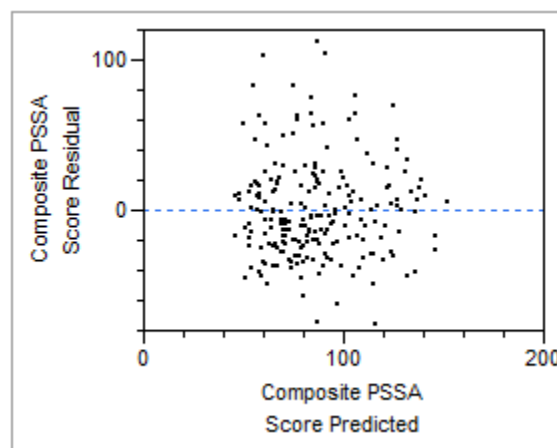
Fig. 11: Residuals by Predicted Plot, Gr. 5, 2007-08

[6] Statistical tests, including nearest-neighbor regression and Moran's *I*, for spatial autocorrelation or clustering of the standardized residuals were performed on each dataset. In only one case, gr. 5, 2005-06, was significant autocorrelation detected ($\alpha \leq 0.05$). This indicates that in 8 of 9 cases the regression models helped to eliminate any existing spatial autocorrelation in *CPS*.

The map in Figure 12 reveals the distribution of school performance for grade 5, 2007-08—based on standardizing the dependent variable, *Composite PSSA Score*, to show high, average, and low performance. Figure 13 shows the geographic variety of the residual values from Figure 11 as distributed in a generally haphazard manner throughout the city. These images present a way of comparing a school's performance before and after students' neighborhood effects have been taken into account. As an example, the magnified circle in Figure 12 highlights one school that shows average performance (white) but shows above-average performance in Figure 13 (pink). A question generated from this data is: What explains the difference between schools with similar student populations based on neighborhood factors but dissimilar school performance?
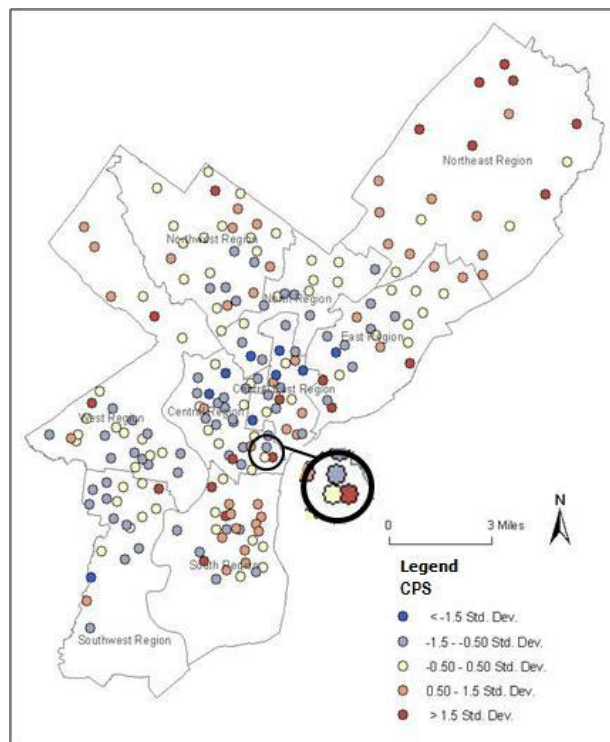
Fig. 12: Geographic Distribution of *CPS*, Gr. 5, 2007-08
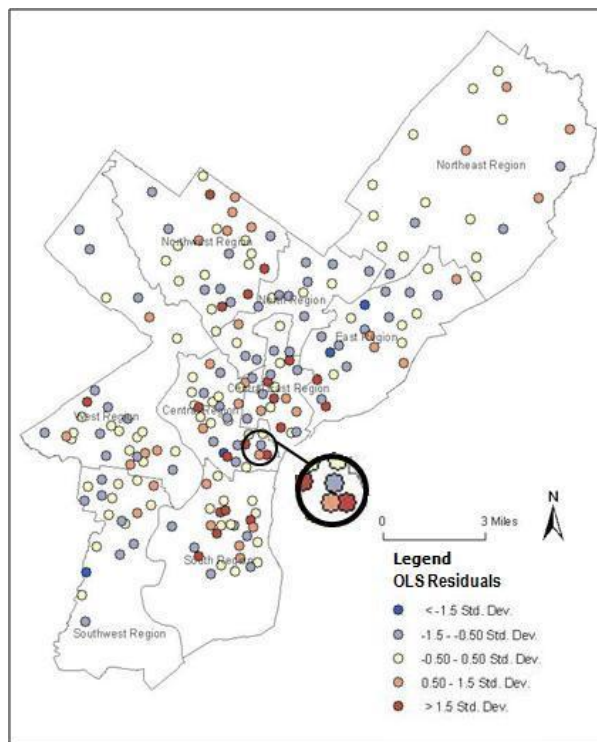
Fig. 13: Geographic Distribution of Residuals from Multiple Regression Model, Gr. 5, 2007-08

According to Pitts and Reeves (1999), "the use of a regression model to account for variation in contextual effects helps to diminish the level of spatial autocorrelation in the residuals as compared to the uncorrected scores" (p. 12). As shown in the visual analysis, neighborhood characteristics are spatially autocorrelated, so autocorrelation of *CPS* can easily be associated

with them. Overall, the models used here, incorporating significant SES-related factors, show that community factors have been substantially linked to school performance in Philadelphia's public schools.

Cross K-Function Analysis

The final phase of the study was to extract the lowest- and highest-performing schools from the data in order to conduct Cross K-function analysis, a comparative method for making inferences about two or more populations. An extension of K-function analysis for a single population, it uses point patterns and takes scale into account, allowing it to become a variable and providing insight that might not develop based on visual analysis alone. In general terms, the statistic $K_{12}(h)$ determines the expected count of population 1 within distance h of population 2 given the observed count and using random permutations (Smith, 2009).

The first test, *k2_global*,[7] compared the two point populations of the highest- and lowest-performing schools based on the first and third quartiles of the dependent variable, *Composite PSSA Score*, and computed *p*-values for clustering of each of these relative to both. The *p*-values at each distance *h* are defined to be the probability of a frequency count greater than the observed value if one of the populations were a random draw from the two. Low *p*-values correspond to significant clustering of one point pattern against the combined point pattern. For the set of bottom or top schools, the null hypothesis was that their locations were consistent with typical random permutations of school locations. The scales specified for the program ranged from 0.0625 to 4.0 miles, and the results of the test for clustering (99 simulations) are listed in Table 6 using the example of grade 8, 2007-08. The maximum radius of 4.0 miles was determined through visual inspection as the distance to which most spatial dependencies could be detected.

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[7] The statistical programs *k2_global* and *k12_perm*_plot were authored by T.E. Smith and run in the MATLAB program.

| Miles	p-values k2_global (clustering) for Lowest-Performing Schools	p-values k2_global (clustering) for Highest-Performing Schools	p-values k12_perm_plot (attraction/ repulsion)
0.0625	0.74	0.66	0.10
0.125	0.74	0.66	0.10
0.25	0.86	0.51	0.11
0.5	0.37	0.15	0.93
0.75	0.09	0.11	1.00
1.0	0.02	0.15	1.00
1.25	0.02	0.24	1.00
1.5	<0.01	0.32	0.99
1.75	<0.01	0.38	0.99
2.0	<0.01	0.46	0.99
2.25	<0.01	0.30	1.00
2.5	<0.01	0.39	0.99
2.75	<0.01	0.57	0.99
3.0	<0.01	0.78	0.98
3.25	<0.01	0.85	0.95
3.5	<0.01	0.90	0.90
3.75	<0.01	0.98	0.83
4.0	<0.01	0.98	0.77

Table 6: Test Results of *k2_global* and *k12_perm_plot*,
Gr. 8, 2007-08

Notice that for the point pattern of the lower quartile schools, there was significant clustering at about three-quarters of a mile and greater relative to the overall pattern of both categories of schools, providing support for the alternative hypothesis. However, for the population of the upper quartile schools, no significant clustering was detected except weakly at a half to one mile, suggesting that these schools were more randomly dispersed throughout the city.

Clustering of the struggling schools was prevalent for grades 5 and 8 during all years at a distance of approximately half a mile and greater. No statistical evidence of clustering of the excelling schools was generated for these groups. Eleventh grade populations deviated from these patterns. For the years 2005-06 and 2006-07, the bottom high schools were found to be distributed quite randomly, but clustering was detected for the top schools between a range of about a half and two miles. In contrast, for grade 11 in 2007-08, clustering was present for the bottom high schools and not for the top. Perhaps this indicates a recent shift in high school achievement. See Appendix B for the complete statistical results of all datasets.

The next test was *k12_perm_plot*, and it compares two point populations by randomly permuting their labels and computing the $K_{12}(h)$ statistic for a range of specified distances. *P*-values are then reported, reflecting significant attraction and/or repulsion between these patterns. Small *p*-values correspond with significant attraction between populations, while large *p*-values indicate repulsion. Moreover, the null hypothesis stated that the observed distributions of the lowest- and highest-performing schools were consistent with random placement based on the coordinates of the schools, assuming that any observed school location could be occupied by either type (Smith, 2009).

Based on the results provided in the far-right column of Table 6, the null hypothesis that the points come from the same population could be rejected. The *p*-values of 1.0 or close to 1.0, which were reported at scales of 0.5 miles and greater, indicate significant *repulsion* of the two point patterns. It could therefore be inferred that the locations of the lowest- and highest-performing schools were significantly different at these distances. Statistical significance weakened around 3.0 miles. Figure 14 offers an alternate way of viewing the *p*-values:
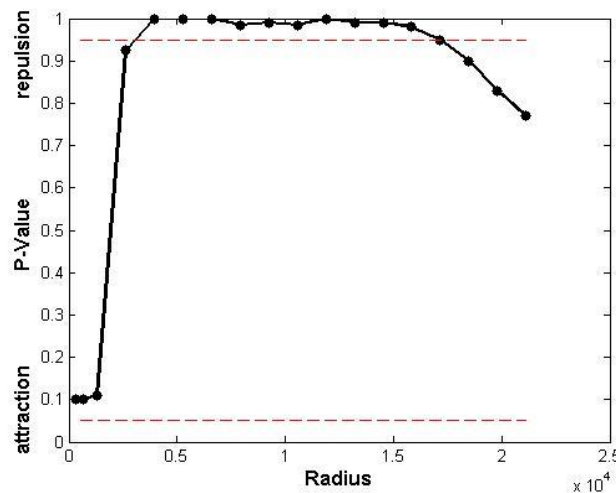
Fig. 14: *P*-values of Random Permutation Test,
Results of *k12_perm_plot*, Gr. 8,
2007-08   (unit=feet)

Notably, the two point patterns approached attraction at very small distances—0.0625 to 0.25 miles (*p*=0.10 and 0.11)—and then suddenly diverted at about 0.5 miles (*p*=0.93). A visual inspection of the map in Figure 15 helps to settle this apparent discrepancy. The encircled areas reveal that, in several cases, schools from each population were closely located—likely at

distances of less than one quarter of a mile. So while there was evidence of global repulsion, in these particular sections of the city the two populations converged.

Finally, the *k12_perm_plot* program is also capable of providing a single random distribution of the two sets of point patterns, which is shown in Figure 16. A visual comparison of this with the observed distribution supports the statistical findings that the weakest schools were generally clustere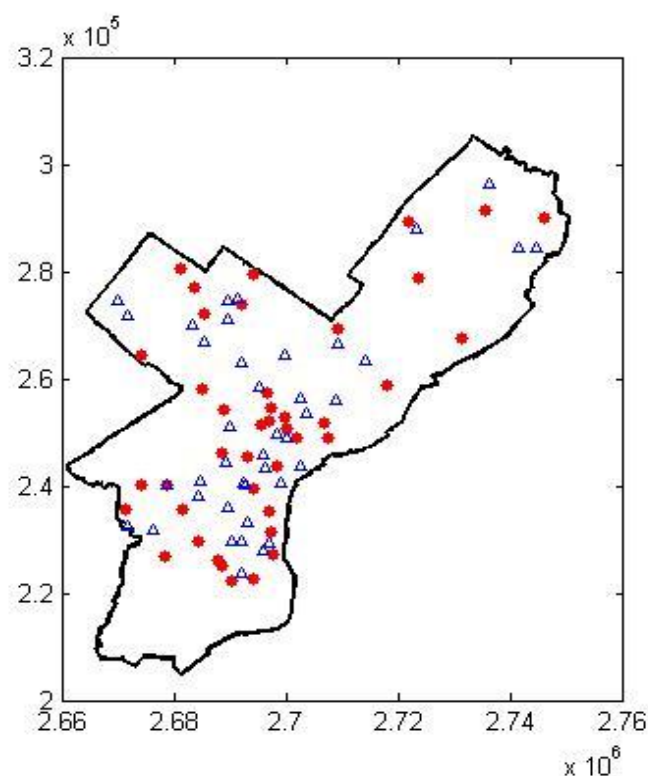d and that the two school populations lacked spatial independence. In reference to the other datasets, repulsion between the lowest- and highest-performing schools was evident in 8 out of the 9 datasets but at varying distances (see Appendix B).
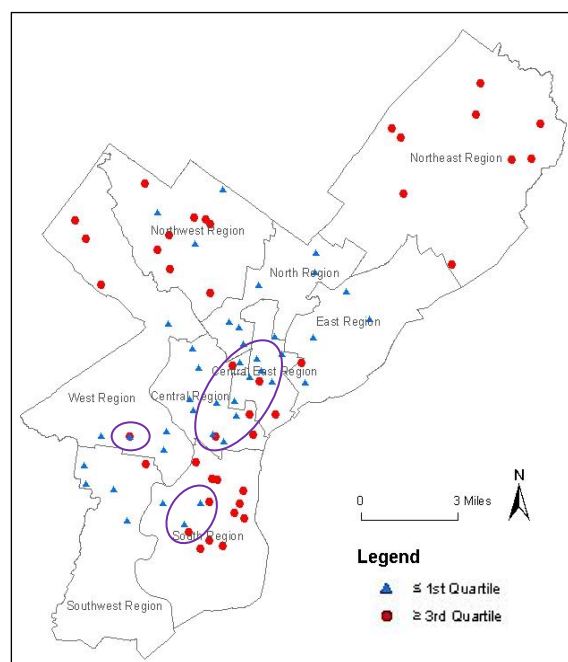
Fig. 15: Observed Distribution of Lowest- and Highest-Performing Schools, Gr. 8, 2007-08

Fig. 16: Random Distribution of Lowest- and Highest-Performing Schools, Gr. 8, 2007-08   (unit=feet)

Findings. This study focused on the relationship between school performance and students' neighborhood characteristics. School grade groups were the unit of analysis; dependent and independent variables were derived from aggregated student PSSA scores and block-group level census data, respectively, for the county of Philadelphia. It specifically relied on spatial analysis methods using geographic information systems (GIS).

School performance in Philadelphia appeared to be spatially autocorrelated and associated with characteristics of the surrounding neighborhood. Maps were especially useful for initially detecting a spatial pattern in the lowest-performing grade 5 and 8 schools as well as in their corresponding neighborhood characteristics. Undeniable interaction existed between their locations and contextual factors: they were often found clustered in minority communities with high rates of poverty in North, West, and Southwest Philadelphia. At the same time, there was a tendency for relatively affluent areas, including the Southeast, Northwest, and Northeast, to circumscribe the high-achieving schools. High schools and the highest-performing elementary schools were found to be more scattered across the city. School type (e.g., charter, selective) plays a role in visually examining the influence of a school's surrounding neighborhood characteristics on its performance. Overall, the statistical findings were supported by the visual observations since the latter provided an easy way to view the demographic attributes that contributed to the clustering of the academically weakest schools.

Several neighborhood characteristics based on a school's student population were strong predictors of school performance. The regression analysis revealed that all but one of the neighborhood variables were predictive of school performance, as measured by *Composite PSSA Score*. With an adjusted R-Square value of about 30%, the linear models produced from Ordinary Least Squares multiple regression often included *Average % of Population Holding Bachelor's or More Advanced Degree*, *Average % of Households with Female Head of Household with Related Children under 18*, and *Average % of Population Non-White and Non-Asian*. Although no socioeconomic index was employed as an explanatory variable, it could be inferred based on the data used here that there was an inverse relationship between the rate of students living in economically disadvantaged communities and school performance on the PSSA. Moreover, the variable measuring the geographic diversity of the student population was

a strong predictor of *CPS*, showing a positive relationship between school performance and the extent to which students were spread throughout many neighborhoods.

The lowest-performing 5th- and 8th-grade schools were significantly clustered, and the locations of the lowest- and highest-performing schools revealed spatial dependence. Struggling elementary and middle schools were significantly clustered at distances of three-quarters of a mile to at least 4 miles. The upper quartile grade 5 and 8 schools did not significantly converge at any distance; these schools were somewhat scattered throughout the city. Starting at about half a mile, the lower- and upper-quartile schools began to repel. Results across grade 11 were not consistent with grades 5 and 8. While clustering of the bottom schools was generally not detected, the top schools were found to be significantly close to each other during 2005-06 and 2006-07. Repulsion of the two populations occurred at varying scales. However, for the most recent school year, grade 11 results deviated from the preceding years and offered the only instance in which no significant repulsion existed between the two quartiles of high schools. These findings were made possible through the statistical method of Cross K-function analysis.

Discussion. The findings of this study diverge into copious policy implications pertaining to equitable assessments of schools, effective school practices, and initiatives that address the plight of economically disadvantaged families and communities. The latter two categories of policy implications, internal and external to schools, respectively, are analogous to the chicken-and-egg puzzle concerning which should be given priority—improving schools or improving neighborhoods. The following discussion suggests that turning around failing schools requires a confluence of strategies. Areas for further research are suggested.

Policy Implications

As education researchers, we have a civic responsibility to provide relevant and rigorous research that informs how we come to understand the interdependencies of the social, cultural, and economic institutions in our communities and how they relate to education processes and outcomes.

- Tate, 2008, p. 408

School Assessment Practices

The results of this study help to confirm what an extensive body of research already shows: "that community socioeconomic context—factors over which local educators have little direct control—affect school climate and student performance to a substantial degree" (Reeves & Grubb, 1997, p. 3). What the present study contributed was to reveal how this is true for the county of Philadelphia using school-level data with spatial analysis methods. The findings suggest that since contextual factors may influence school performance, and are spatially autocorrelated, it is important to recognize this when evaluating schools. According to Reeves and Grubb (1997), considering the interaction between neighborhood characteristics and student achievement is essential to fairly assessing schools: "When we correct for the effects of these community influences, the result will be a truer picture of how the school system itself supports student performance" (p. 8). Without acknowledging contextual effects, the performance of schools is easily being under- and over-stated (Pitts and Reeves, 1999).

This approach is not to be interpreted as mollifying standards or being lenient in the evaluation of failing schools given that their students come from disadvantaged populations. Researchers and practitioners alike contend that these schools lack the quality of leadership, staff, and other resources to which their higher-performing counterparts are accustomed. The purpose of taking contextual effects into account, therefore, is to refine the method for judging school improvement. Like many other districts, Philadelphia schools are traditionally rewarded and punished primarily based on standardized test performance. A measure of a school's demographic context can be incorporated as a variable in a growth model that helps determine whether or not students and schools are progressing. At the same time, acknowledging neighborhood factors influencing student achievement may aid the development of appropriate school-based interventions, preventing schools from being subjected to "one size fits all" reforms that do not address the specific challenges of their student populations.

From the Inside Out…

This leads into a discussion concerning the ability of schools and the district to implement programmatic and systemic reform that can improve educational outcomes for economically

disadvantaged student populations. Based on the data and methods used in the present study, neighborhood effects explained a little more than a third of the variation in school performance. In addition, there were schools with similar student populations that produced different academic outcomes. This reinforces the notion that there are substantial school-level conditions that impact student achievement. Moreover, valuable information might be provided through a careful investigation of the schools that exhibit high performance, net of students' demographic characteristics, to identify particularly effective practices. What, exactly, is happening at schools whose student populations are typical of others' but perform above average on high-stakes assessments such as the PSSA? A closer look may reveal longer school days, a greater percentage of highly effective teachers, intensive test preparation, or other factors contributing to the difference. Anecdotally speaking, some school administrators actively oppose social promotion of students who struggle academically. Instead of passing to the next grade level, children who do not meet standards in core subjects are retained. Often a student who repeats the grade will perform proficiently the second time around, so this practice boosts a school's performance. On the other hand, a parent may wish to withdrawal his or her child from the school in this situation, which may also benefit a school's outcomes on assessments.

Moreover, the variable measuring the geographic variety of the neighborhoods in which students live, *Geographic Diversity*, proved to be a significant predictor across all grades and years. In fact, greater geographic diversity was found to be associated with higher achievement. Given that Philadelphia is comprised of communities that vary demographically, this finding lends support to socioeconomic integration as a systemic policy solution, which was briefly discussed in the Introduction. The effect of this approach is comparable to racial desegregation, and Darling-Hammond (2004) has pointed to one argument that often appears in discussions advocating for integration: "by having those with more power in the schools with those who have less, it may be harder to maintain the inequalities that are otherwise inflicted on those with little voice and clout" (p. 4).

As was the case with racial integration, pushback on SES integration, especially using busing, would be inevitable. In addition, there is a feasibility issue concerning the proximity of low- and middle/upper-income communities. However, the reality is that a majority of students living in

disadvantaged communities are not attending schools of comparable quality to those attended by their middle- and upper-class peers. Disrupting the status quo as far as the composition of student populations ought to have a place in the discussion about systemic issues impacting achievement. Support for this policy is provided by a study conducted by economist Susan Mayer. She found that (quoted in Conley, 1999):

> [S]tudents attending schools with a greater proportion of students from well-off families had a significantly higher likelihood of completing high school, net of the students' own backgrounds. Furthermore, this effect of a school's socioeconomic composition was much stronger for those students who themselves were from disadvantaged backgrounds. (p. 62)

The School District of Philadelphia currently does not use SES integration as a factor in assigning students to their schools.

One trend to monitor is the upsurge in the number of charter schools opening in Philadelphia. With the Obama administration supporting and investing in auspicious, innovative school models across the country, the growth of charter schools is inevitable. These schools may increase socioeconomic integration because they are generally not required to draw their student populations from local catchment areas, but they may also lead to increased inequity by privileging those students whose families have the wherewithal to participate successfully in school choice. Charters can present both programmatic and systemic reform and offer students living in any community an alternative to neighborhood schools. However, the performance of these schools as a whole is currently, as the findings above show, indistinguishable to the performance of district-managed schools in Philadelphia.

From the Outside In…

The finding that the locations of the lowest- and highest-performing schools tended to be spatially dependent (i.e., generally did not neighbor each other) suggests that children growing up in these communities encounter distinct life experiences and opportunities. Neighborhoods, including the families that form them, play an important role in shaping an individual's life chances. The most salient predictors of school performance found in this study were

neighborhood characteristics dealing with educational attainment, family type, and race—the first of which is directly linked to social class and the latter two, indirectly. Building up the social capital of families and improving neighborhoods, therefore, are essential to narrowing the achievement gap in Philadelphia since poverty is undeniably linked to low achievement.

As discussed in the Visual Analysis section, female-headed families and minority populations were inversely associated with college degree attainment. Social scientists have often pointed to structural forces—most notably ongoing residential segregation—as the causes of these inequalities. The interaction between family type and student achievement is mainly socioeconomic (Conley, 1999; Battle, 1998; Finn & Owings, 1994). As Wilson (2009) has pointed out, "Children living in households headed by single mothers are America's poorest demographic group" (p. 102). In Philadelphia, there is evidence that the trend of female-headed households may remain steady for some time. For a study published in 2005, Kathryn Edin and Maria Kefalas collected and analyzed data on low-income African-American, Caucasian, and Puerto Rican single mothers in Camden, New Jersey and eight poor Philadelphia neighborhoods. They found that despite the economic hardships of raising children alone, the low-income single mothers prioritized motherhood over obtaining marriage-worthy men (cited in Wilson, 2009). In contrast, middle- and upper-class women "often put off marriage and child-bearing to pursue economic goals" (Wilson, 2009, p. 127).

An implication of incorporating culture as a factor in explaining educational outcomes is that narrowing the socioeconomic and racial achievement gaps will require interventions that address social norms endemic to low-achieving populations. The trend of high academic achievement gained by low-income children of various immigrant groups that are characterized by strong family and community commitment to education supports this argument. To offset the consequences detrimental to student achievement encountered by many children raised in poor, persistently low-achieving families and communities, non-profit organizations as well as locally- and state-funded entities can provide programs focused on educating parents. "Baby College" of the Harlem Children's Zone (HCZ, 2009b) and "Parent University" of the School District of Philadelphia (SDP, 2009b) are two examples that include a series of training workshops that sensitively teach parents the best practices for enhancing brain development early on and

supporting children's academic success. Parent knowledge and empowerment may also present an effective way to break the cycle of academic failure. It has already been confirmed through multiple research studies that a child's educational attainment is most strongly determined by the educational attainment of his or her parents (Hauser-Cram, 2009; Young & Smith, 1997).

A broader, and much more ambitious, policy implication from the findings of this modest report involves reducing residential segregation, breaking up areas of high minority and poverty concentration. This massive undertaking addresses a powerful structural challenge to equalizing educational opportunities. Community activist Angela Glover Blackwell (2006) reflects:

> *Brown v. Board of Education* marked a transformative moment in American history, yet more than 50 years later, many public school districts are in effect re-segregating based on housing patterns—locking many low-income children of color in failing, overcrowded schools with woefully limited resources. (p. 100)

Based on the analyses presented in this paper, the *de facto* residential segregation apparent in much of Philadelphia often separated excelling schools from struggling schools and thereby limited educational opportunities for low-income youth of color. A major hindrance to this policy alternative is the historical pattern of "white flight" in which white communities become intolerant of an African-American presence greater than 15% and sell their homes, settling where the minority population is either smaller or nonexistent, thus contributing to residential segregation (Epps, 2002; Clark, 1965). Despite the threat of white flight, there are several steps that policymakers can take toward ensuring broad access to varied communities, and a few are listed here (Smiley, 2006):

- Expand affordable housing choices in opportunity-rich neighborhoods.
- Build more mixed-income housing near public transit.
- Ensure minority representation on planning organizations and regional transportation authorities.

Finally, we must also ameliorate the conditions of impoverished neighborhoods. The relationship between neighborhood factors and school performance suggests that more should be done to

revitalize struggling areas across the Philadelphia region. Fostering economic development is one strategy that can deeply impact this effort and reduce concentrated poverty. According to Marc H. Morial (2006), the eighth president of the National Urban League, closing the wealth gap is crucial to the nation's future because "a productive, working America with a strong middle class is the only way we can compete globally in the 21st century" (p. 169). The following are examples of specific measures that can be taken to uplift the economic conditions of Philadelphia's struggling neighborhoods and that can be implemented by a range of committed stakeholders (Smiley, 2006):

- Make mortgages more available and affordable to people of all income levels.
- Increase business development and entrepreneurship in low-income communities.
- Commit to job training and career counseling efforts for youth.

Raising the achievement of students living in all of Philadelphia's communities will require an esemplastic approach. Programmatic as well as systemic solutions are essential to addressing the problem in its entirety. A growing body of research confirms that cultural and structural forces, which are often confounded, interact in a way that perpetuates social and economic inequalities (Wilson, 2009). Today, our economy increasingly relies on a college-educated workforce, and this trend will only exacerbate troublesome divisions among the classes unless we commit to ensuring that children, regardless of where they live, have a fair chance at a quality education.

Further Research

There are several ways that this study could be enhanced. Very few school-based variables were used in this study, and they were not incorporated into the multiple regression models to control for neighborhood effects. Considering the modest R-Square value of the linear regression models, there were significant independent variables missing that could help to explain variation in school performance. Perhaps pooling school-based and neighborhood-based explanatory variables into the stepwise regression would foster greater understanding about influences on student achievement. A more comprehensive study would also include such factors as the percentage of highly effective teachers and the school principal's years of experience to better isolate neighborhood effects. As stated in the Introduction, the tasks of determining, measuring,

and reporting some school-based influences on student achievement are currently quite difficult. However, it is important to accomplish these in order to conduct effective empirical research that can inform education policy.

In addition, it would be interesting to determine if a measure of wealth would prove to be an important explanatory variable. This study employed individual components of wealth and social class, but as Conley (1999) suggests, independently these only tell part of the story. Perhaps a wealth index would remove the impact of race in some of the linear models, showing the importance of the complex class-based variable for predicting student outcomes, and support Conley's claim that, "Race matters, but only indirectly—through the realm of class inequality" (1999, p. 80).

The independent variables were based on 2000 Census data while the dependent variable was based on more recent years. It is likely that demographic characteristics have changed at least slightly over the decade for Philadelphia County, and for this reason updated independent variables would increase the reliability of the analysis. Perhaps with the upcoming 2010 Census, students' neighborhood characteristics can be reassessed and their influence on school performance reexamined.

The study was performed for three different grade levels over three school years. Delving more deeply into the varied influences of neighborhood characteristics on particular groups of students by grade level may inform policy that is better designed for elementary, middle, and high schools. Further research should address why some contextual factors are more strongly linked to student achievement at particular grade levels than others.

Conclusion. The intention for this paper was to shed light on the interconnectedness of student achievement and neighborhood characteristics as reflective of insidious sociological realities in the context of Philadelphia's public schools and varied communities. Using visual, linear regression, and K-function analyses, it was found that students' neighborhood characteristics and schools' academic performance are onerously linked. The results of the study indicate that factors external to schools, such as rates of college degree attainment in students' communities,

are strong predictors of *Composite PSSA Score*, which served as the measure of school performance. Indicators of low socioeconomic status, such as the proportion of families living below the poverty level, were inversely associated with *CPS*. Further evidence of neighborhood effects was provided through the finding that the geographic distribution of school performance is not random.

In closing, I would like to highlight a relevant current event that addresses the social and economic disparities revealed in this report as they pertain to educational opportunity. On July 13, 2009, a nearly 40-year-old Philadelphia school desegregation case came to an end. *Pennsylvania Human Relations Commission v. School District of Philadelphia* (1973) postulated access to a quality education a civil right of which African-American and Hispanic youth were untenably denied due to illegal racial segregation in the district (SDP, 2009c). Led by Superintendent Dr. Arlene Ackerman, the district's new five-year strategic plan, *Imagine 2014*, serves as the basis for this historic settlement. *Imagine 2014* addresses four guiding principles: "supporting programs that increase achievement for all students; addressing inequities in the allocation of all district resources; holding adults accountable; and engaging parents, students, and community" (SDP, 2009d, pp. 4-5). Hopefully, this framework, with intransigent urgency, will address the complex relationships that perpetuate the educational opportunity gap, ensuring sustainable scholastic improvement for students throughout the county of Philadelphia.

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APPENDIX A: Description of the Geography and Variables

School Geography and Variables. The school locations were provided by the School District of Philadelphia. The coordinates of each school were geocoded using ESRI's ArcMap and projected according to the State Plane Coordinate System for 1983 that divides each of the 50 states into as many as 10 different zones. Each school had a unique location ID with which students were identified.

Composite PSSA Score (*CPS*): dependent variable

Source: Pennsylvania Department of Education

Calculation: Sum of a school's percentages of students who scored proficient or advanced in reading and math

Range of Possible Values: 0-200

Notes: PSSA stands for Pennsylvania System of School Assessment and is a standards-based criterion-referenced assessment used to measure a student's attainment of the academic standards while also determining the degree to which school programs enable students to attain proficiency of the standards. Student results are reported as either advanced, proficient, basic or below basic. In 1999, Pennsylvania adopted academic standards for Reading, Writing, Speaking and Listening and for Mathematics. These standards identify what a student should know and be able to do at varying grade levels. School districts have the freedom to design curriculum and instruction to ensure that students meet or exceed the standards. Every Pennsylvania student in grades 3 through 8 and 11 is assessed in reading and math (Pennsylvania Department of Education, 2009a). There has been an ongoing, contentious debate over the reliability and efficacy of high-stakes tests such as this one, but the consensus is that it is necessary to provide a standardized form of assessment by which to measure student progress and evaluate schools. Grades 5, 8 and 11 were chosen for this study since they represent critical points in the elementary, middle, and high school years. For quite some time, these grade levels have been focal in the evaluation of schools by the state and district. Percentages of reading and math proficiency, which are highly correlated at about $r=0.90$, were combined to capture achievement in both subjects.

Student Enrollment (*Enrollment*)

Source: School District of Philadelphia

Calculation: Count of student IDs by grade group for each school

Range of Possible Values: 1-714

Expected Correlation with *CPS*: negative

Notes: This is the number of students in the specified grade group (i.e., 5th, 8th, or 11th) for a school. There have been mixed research findings about the effect of school size on student achievement (Betts et al., 2003). Although enrollment size by grade and class size are two different things, in some cases a school may have had only one class per grade, and so these would have been equal. Small classes (<25 students) are considered more conducive to teaching and learning than larger classes.

Geographic Diversity of the Student Population (*Geographic Diversity*)

Source: School District of Philadelphia

Calculation: 1) Count of students in each block group 2) Count of block groups by school 3) Divide number of block groups by number of students

Range of Possible Values: 0.0-1.0

Expected Correlation with *CPS*: positive

Notes: This variable provided a measure of the geographic variety of the student population. For each school according to the grade level and year for the dataset, it is the ratio of the number of block groups in which students lived to the school grade group's enrollment. A low value indicates that students came from few block groups, while a high value indicates that students came from many block groups. The ratio may correlate strongly with a school's level of socioeconomic (SES) diversity, but this is dependent on the variety of students' neighborhood characteristics.

School Type

Source: School District of Philadelphia

Calculation: none

Range of Possible Values: Traditional (0) or Charter (1)

Expected Correlation with *CPS*: none

Notes: This is a dummy variable indicating the school as charter or traditional. Charter schools are publicly financed but managed by groups separate from school districts. Students must apply but are then selected by lottery to attend these schools. Traditional schools, also known as neighborhood schools, draw their students from surrounding catchment areas. There are no admittance requirements for these schools. A recent report provided by the RAND Corporation was based on an evaluation of Philadelphia's charter schools. The overall finding was that "students' average gains attending charter schools are statistically indistinguishable from the gains they experience while at traditional public schools" (Zimmer, Blanc, Gill, & Christman, 2008, iii). Educational Management Organizations (EMOs) were responsible for the day-to-day management of less than 10% of all public schools during 2008-09. These schools were grouped with traditional schools.

There are three types of public high schools. In addition to neighborhood high schools, there are two selective high school types: citywide admission and special admission. Students may attend a neighborhood high school if their 8th grade school is in the secondary school's feeder pattern. Citywide admission schools require that applicants meet certain academic and behavioral criteria and then select students by computerized lottery. Finally, special admission schools are the most selective, with high academic and behavioral standards.

% English Language Learners (*%ELL*)

Source: School District of Philadelphia

Calculation: none

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: ELL stands for English language learner. This variable measured the percentage of students classified as ELL in a school.

% Receiving Free or Reduced-Price Lunch (*%FRL*)

Source: School District of Philadelphia

Calculation: none

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: FRL stands for free/reduced-price lunch and was used as a measure of a school's low-income student population. Any child at a participating school may purchase a meal through the National School Lunch Program. Children from families with incomes at or below 130% of the poverty level are eligible for free meals. Those with incomes between 130% and 185% of the poverty level are eligible for reduced-price meals, for which students can be charged no more than 40 cents. For the period July 1, 2008, through June 30, 2009, 130% of the poverty level was $27,560 for a family of four; 185% was $39,220 (United States Department of Agriculture, 2009).

% Receiving Special Education Services (%SpecialEd)

Source: School District of Philadelphia

Calculation: none

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: This variable indicates the percentage of students who received special education services (e.g., for learning disabilities, speech impairment).

Student/Neighborhood Geography and Census Variables. The independent variables used to represent student neighborhood characteristics came from block group data provided by the U.S. Census. Summary File 3 presents in-depth population and housing data collected on a sample basis from the Census 2000 long form questionnaire, as well as the topics from the short form 100-percent data (age, race, sex, Hispanic or Latino origin, tenure [whether a housing unit is owner- or renter-occupied], and vacancy status). This file presents data from the population and housing long form, also known as the "Sample Data" because they are obtained from questions asked of a sample (generally 1-in-6) of persons and housing units (U.S. Census Bureau, 2009a). Block group geography was also provided by the Census (Table: dt_dec_2000_sf3_u_geo).

A block group is the smallest geographic unit for which the Census Bureau tabulates sample data. A subdivision of a census tract, it generally contains between 600 and 3,000 people, with an

optimum size of 1,500 people (U.S. Census Bureau, 2009b). The County of Philadelphia has 1,816 block groups. Thirty-one of the block groups were removed using list-wise deletion because each had a population size of zero, resulting in a total of 1,785 block groups. When needed, calculations were completed in Microsoft Excel, and variables were normalized by population. For each Census variable, geocoded students were spatially joined to their corresponding block groups in ESRI's ArcMap. Then an

Total Students Geocoded			
	Gr. 5	Gr. 8	Gr. 11
2005-06	13947	13098	9858
2006-07	14642	14850	10895
2007-08	14653	14737	11793

average of student percentages by school was calculated in Microsoft Access. Student locations were provided by the School District of Philadelphia on premises during the author's internship.

One assumption about these variables is that they are representative of the circumstances present during the years 2005-2008 (for which the dependent variable was used). As noted by Wilson (2009), the late 1990s were characterized by an economic boom during the Clinton administration, and this period certainly influenced the data collected for the 2000 Census. The economic downturn following September 11th in 2001 resulted in devastating consequences such as increased unemployment and poverty. Expected correlations and notes are based on the hypothesis that socioeconomic and racial contextual factors impact school performance in Philadelphia's public schools.

Source: 2000 U.S. Census, http://www.americanfactfinder.gov/

Average Median Household Income (*AvgMedHshdInc*)

Calculation: none, Households: Median household income in 1999

Range of Possible Values: 0-200,001

Expected Correlation with *CPS*: positive

Notes: Income serves as a basic indicator of SES status. The financial resources of a community's residents have long been associated with the quality of its schools. There were 10 cases in which the median household income for a populated Philadelphia County block group was reported as "0."

Average Total Population (*AvgPop*)

Calculation: none, Total population: Total

Range of Possible Values: 5-4012

Expected Correlation with *CPS*: none

Notes: "Despite the common perception that urbanization, and the higher population density that accompanies it, leads to increased crime, higher rates of mental illness, and a general decline in health, researchers have concluded that 'while density at the macro-level probably has some minor pathological effects, it is not a variable of major substantive importance'" (quoted in Conley, 1999, p. 66).

Average % of Families below Poverty Level (*Avg%Families<Poverty*)

Calculation: Divide Families: Income in 1999 below poverty level by Families: Total

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: This was used as a measure of concentrated poverty.

Average % of Population Holding Bachelor's or More Advanced Degree (*Avg%PopBachDeg≥*)

Calculation: 1) Sum Population 25 years and over: Bachelor's, Master's, Professional, and Doctorate degrees for Males and Females 2) Divide sum by Population 25 years and over: Total

Range of Possible Values: 0-100

Expected Correlation with *CPS*: positive

Notes: Educational attainment serves as a basic indicator of SES status. Several studies have found that parent education level is a strong predictor of student achievement (Hauser-Cram, 2009; Conley, 1999; Young & Smith, 1997).

Average % of Population Holding High School Diploma or Equivalency Only (*Avg%PopHSDiploma*)

Calculation: 1) Sum Population 25 years and over: High school graduate (includes equivalency) for Males and Females 2) Divide sum by Population 25 years and over: Total

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: In the current job market, there is increasing need for jobseekers to have college degrees. Those who do not attend or finish college often accept low-paying jobs or do not work at all. This variable relates to educational attainment, a core factor of SES status. As noted above, educational attainment of children is highly correlated with that of their parents.

Average % of Families with Female Head of Household with Related Children under 18 (*Avg%FemHshdKids<18*)

Calculation: Divide Families: Other family; Female householder; no husband present; With related children under 18 years by Families: Total

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: Single-parent households are commonly perceived as being more financially- and emotionally-strained than two-parent households due to family responsibilities resting on one adult. Several studies have found that the impact of family type, specifically the gender and number of parents heading households, is reduced or eliminated when controlling for SES status (Finn & Owings, 1994; Conley, 1999; Battle, 1998).

Average % of Population Non-White (*Avg%PopNonWhite*)

Calculation: 1) Sum race categories except for Total population: White alone 2) Divide sum by Total population: Total

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: The enduring racial/ethnic achievement gap between whites and minorities provides support for using this variable as a predictor of school performance.

Average % of Population Non-White and Non-Asian (*Avg%PopNonWhAs*)

Calculation: 1) Sum race categories except for Total population: White alone and Total population: Asian alone 2) Divide sum by Total population: Total

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: Asian-American students have consistently demonstrated high academic achievement compared to other minority groups. Removing them from the pool of minorities may reveal a stronger relationship between race and school performance.

Average % of Population Not in Labor Force (*Avg%PopNonLaborForce*)

Calculation: 1) Sum Population 16 years and over: Not in labor force by Population 16 years for Males and Females 2) Divide sum by Population 16 years and over: Total

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: High percentages of residents who are not in the labor force may be indicative of large youth, elderly, and disabled populations, among others.

Average % of Population under Age 25 (Avg%Pop<Age25)

Calculation: 1) Sum age categories 25 and under for Males and Females 2) Divide sum by Total population: Total

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: High percentages of youth may be associated with reduced wealth since a large portion of the population is not in the labor force.

Average % of Population Unemployed (*Avg%PopUnemployed*)

Calculation: 1) Sum Population 16 years and over; In labor force; Civilian; Unemployed for Males and Females 2) Divide sum by Population 16 years and over: Total

Range of Possible Values: 0-100

Expected Correlation with *CPS*: negative

Notes: "In the segregated inner-city ghettos, the breakdown of the informal job information network magnifies the problems of *job spatial mismatch*—the notion that work and people are located in two different places" (Wilson, 2009, p. 10).

APPENDIX B: Statistical Results – All Datasets

Table 1: Neighborhood Characteristics: Coefficient Estimate of Each Explanatory Variable on *CPS*

	AvgMed HshdInc	*AvgPop*	*Avg%Famlies <Poverty*	*Avg%Pop BachDeg≥*	*Avg%Pop HSDiploma*	*Avg%Fem HshdKids<18*	*Avg%Pop NonWhite*	*Avg%Pop NonWhAs*	*Avg%PopNon LaborForce*	*Avg%Pop< Age25*	*Avg%Pop Unemployed*
2005-06											
Gr.5	0.0024***	0.0336***	-1.5307***	2.5859***	-0.3644	-2.0973***	-0.6544***	-0.6363***	-2.1739***	-3.7002***	-3.6306***
Gr. 8	0.0026***	0.0339**	-1.7136***	2.9381***	-0.5695	-1.8376***	-0.6376***	-0.6392***	-2.9647***	-3.7850***	-3.8528***
Gr. 11	0.0001***	0.0013*	-0.0538***	0.1020***	-0.0357	-0.0635***	-0.0130**	-0.0128**	-0.0822**	-0.1276***	-0.1161***
2006-07											
Gr. 5	0.0023***	0.0320***	-1.3991***	2.3247***	-0.3178	-3.2713***	-0.5872***	-0.5546***	-1.8742***	-3.2713***	-3.0633***
Gr. 8	0.0026***	0.0364***	-1.6360***	3.0065***	-0.7297	-2.0315***	-0.6845***	-0.6593***	-2.5425***	-3.4787***	-3.6714***
Gr. 11	0.0001***	0.0013**	-0.0345***	0.0721***	0.0007	-0.0433***	-0.0101**	-0.0097**	-0.0517**	-0.0949***	-0.0745***
2007-08											
Gr. 5	0.0026***	0.0337***	-1.601***	2.5569***	0.3052	-1.8602***	-0.6439***	-0.6069***	-2.526***	-3.3180***	-3.3752***
Gr. 8	0.0020***	0.0385***	-1.4801***	2.2362***	0.0307	-1.7698***	-0.6189***	-0.5949***	-1.9828***	-3.3331***	-3.0747***
Gr. 11	<0.0001***	0.0011**	-0.0370***	0.0762***	0.0280	-0.0443***	-0.0110***	-0.0110***	-0.0613***	-0.0902***	-0.0779***

*p<0.10, **p<0.05, ***p<0.01

Table 2: School Characteristics: Coefficient Estimate of Each Explanatory Variable on *CPS*

	Enrollment	Geographic Diversity	School Type	%ELL	%FRL	%SpecialEd
2005-06						
Gr. 5	-0.0190	32.3889***	3.9900	-	-	-
Gr. 8	-0.0160	43.3526***	-3.3481	-	-	-
Gr. 11	0.0009	1.3957***	0.1491	-	-	-
2006-07						
Gr. 5	0.0175	27.5833**	-5.1043	-	-	-
Gr. 8	-0.0393	55.9715***	7.8927	-	-	-
Gr. 11	-0.0001	1.6947***	0.2200	-	-	-
2007-08						
Gr. 5	0.05790	34.4987***	6.7134	-0.2622	-1.6633***	-1.5916***
Gr. 8	-0.0347	47.8842***	9.4264	-0.5132	-1.6331***	-1.3061***
Gr. 11	-0.0006	1.8044***	0.2007	-0.0313*	-0.0362***	-0.0560***

*p<0.10, **p<0.05, ***p<0.01

Figures 1-9: Lowest- and Highest-Performing Schools, based on *CPS* Quartiles
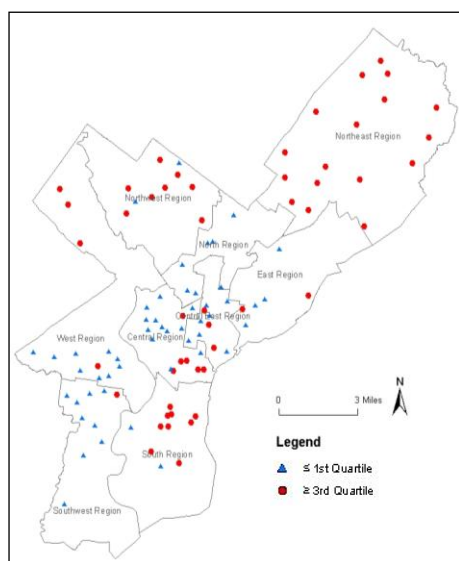
Fig. 1: Gr. 5, 2005-06
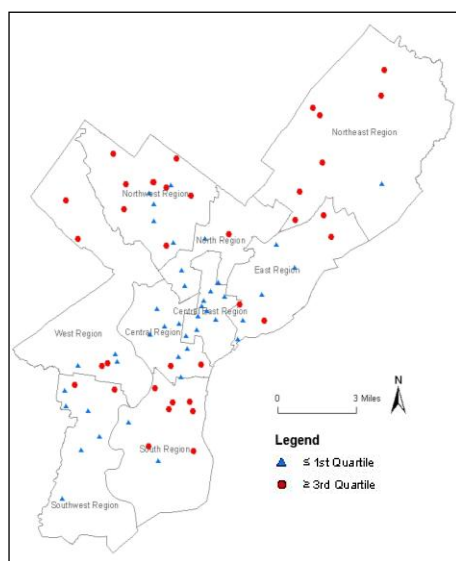
Fig. 2: Gr. 8, 2005-06
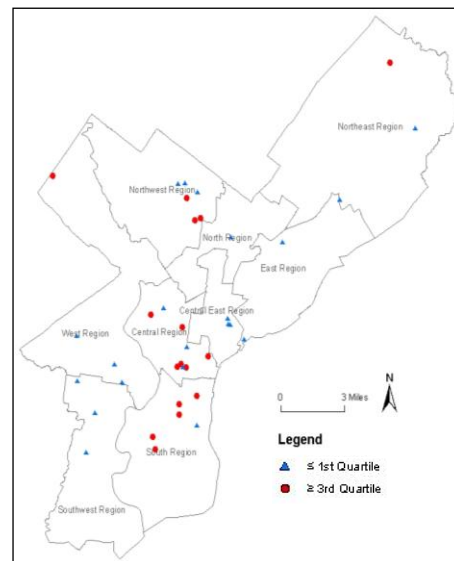
Fig. 3: Gr. 11, 2005-06
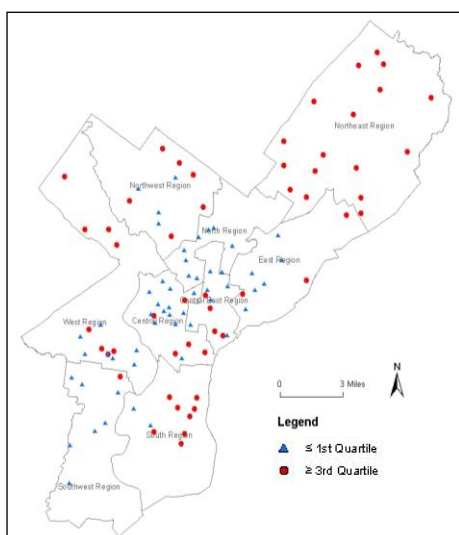
Fig. 4: Gr. 5, 2006-07
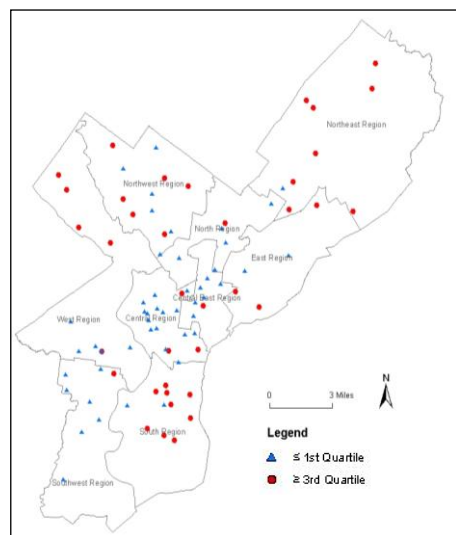
Fig. 5: Gr. 8, 2006-07
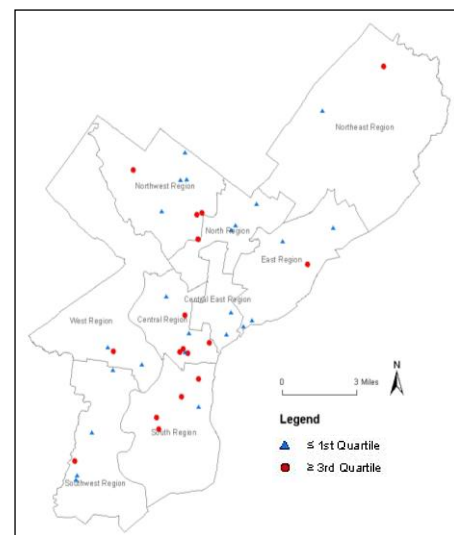
Fig. 6: Gr. 11, 2006-07
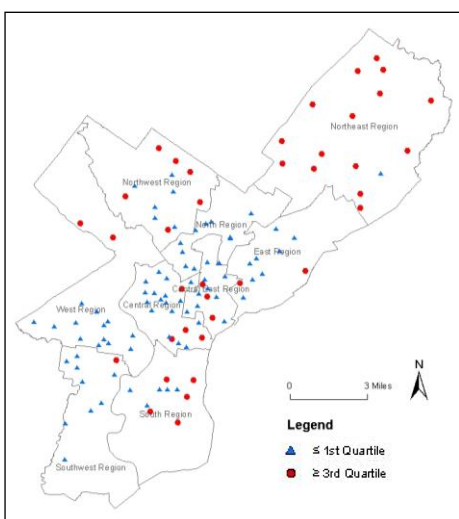
Fig. 7: Gr. 5, 2007-08
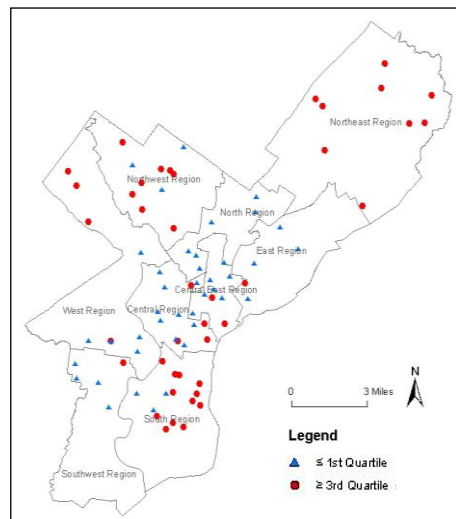
Fig. 8: Gr. 8, 2007-08
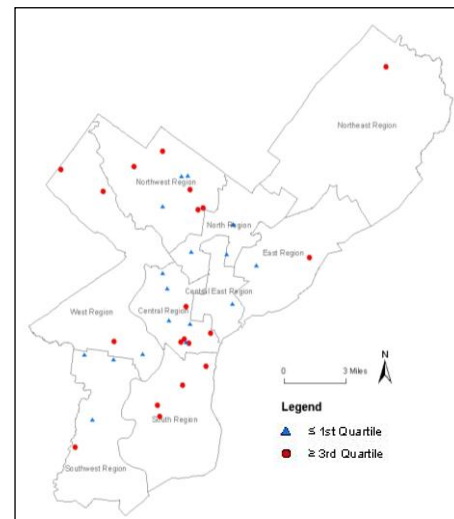
Fig. 9: Gr. 11, 2007-08

Table 3: *P*-values for *k2_global* (test for clustering)

Miles	Gr. 5, 2005-06 ≤Q1	≥Q3	Gr. 8, 2005-06 ≤Q1	≥Q3	Gr. 11, 2005-06 ≤Q1	≥Q3	Gr. 5, 2006-07 ≤Q1	≥Q3	Gr. 8, 2006-07 ≤Q1	≥Q3	Gr. 11, 2006-07 ≤Q1	≥Q3	Gr. 5, 2007-08 ≤Q1	≥Q3	Gr. 8, 2007-08 ≤Q1	≥Q3	Gr. 11, 2007-08 ≤Q1	≥Q3
0.0625	0.50	0.50	0.50	0.50	0.14	0.63	0.73	0.30	0.73	0.18	0.65	0.08	0.44	0.13	0.74	0.66	0.01	0.69
0.125	0.50	0.50	0.50	0.50	0.06	0.70	0.73	0.30	0.73	0.18	0.65	0.08	0.44	0.13	0.74	0.66	0.01	0.69
0.25	0.67	0.09	0.32	0.70	0.08	0.40	0.44	0.72	0.55	0.66	0.59	0.06	0.41	0.40	0.86	0.51	0.26	0.28
0.5	0.01	0.59	0.04	0.42	0.12	0.12	0.04	0.85	0.04	0.62	0.52	0.03	<0.00	0.98	0.37	0.15	0.18	0.20
0.75	<0.01	0.80	<0.01	0.86	0.10	0.27	<0.01	0.77	<0.01	0.98	0.63	0.12	0.01	0.90	0.09	0.11	0.22	0.52
1.0	<0.01	0.57	0.01	0.64	0.37	0.04	<0.01	0.71	<0.01	0.92	0.66	0.02	<0.01	0.94	0.02	0.15	0.51	0.26
1.25	<0.01	0.54	<0.01	0.84	0.59	0.05	<0.01	0.88	<0.01	0.90	0.57	0.03	<0.01	0.95	0.02	0.24	0.19	0.29
1.5	<0.01	0.65	<0.01	0.64	0.85	0.01	<0.01	0.95	<0.01	0.86	0.87	0.01	<0.01	0.99	<0.01	0.32	0.38	0.20
1.75	<0.01	0.66	<0.01	0.78	0.91	<0.01	<0.01	0.98	<0.01	0.88	0.91	0.01	<0.01	0.98	<0.01	0.38	0.41	0.26
2.0	<0.01	0.69	<0.01	0.92	0.78	0.01	<0.01	0.99	<0.01	0.93	0.93	0.04	<0.01	0.99	<0.01	0.46	0.16	0.55
2.25	<0.01	0.71	<0.01	0.88	0.86	<0.01	<0.01	0.99	<0.01	0.89	0.90	0.08	<0.01	0.96	<0.01	0.30	0.15	0.69
2.5	<0.01	0.82	<0.01	0.94	0.96	0.01	<0.01	0.99	<0.01	0.94	0.93	0.07	<0.01	0.97	<0.01	0.39	0.17	0.66
2.75	<0.01	0.88	<0.01	0.95	0.91	0.04	<0.01	0.99	<0.01	0.95	0.94	0.07	<0.01	0.97	<0.01	0.57	0.04	0.82
3.0	<0.01	0.97	<0.01	0.98	0.89	0.06	<0.01	0.99	<0.01	0.98	0.92	0.14	<0.01	0.98	<0.01	0.78	0.02	0.86
3.25	<0.01	0.98	<0.01	0.99	0.88	0.07	<0.01	0.99	<0.01	0.98	0.88	0.07	<0.01	0.99	<0.01	0.85	0.02	0.81
3.5	<0.01	0.98	<0.01	0.99	0.90	0.13	<0.01	0.99	<0.01	0.98	0.86	0.17	<0.01	0.99	<0.01	0.90	0.02	0.90
3.75	<0.01	0.99	<0.01	0.99	0.88	0.20	<0.01	0.99	<0.01	0.99	0.89	0.20	<0.01	0.98	<0.01	0.98	0.03	0.93
4.0	<0.01	0.99	<0.01	0.99	0.89	0.21	<0.01	0.99	<0.01	0.99	0.87	0.14	<0.01	0.98	<0.01	0.98	0.04	0.91

Notes: "Q" = quartile. *P*-values of 0.05 and smaller indicate significant clustering at the corresponding distance.

Figures 10-18: *P*-values for *k12_perm_plot* (test for attraction/repulsion of lowest- and highest-performing schools) unit=feet
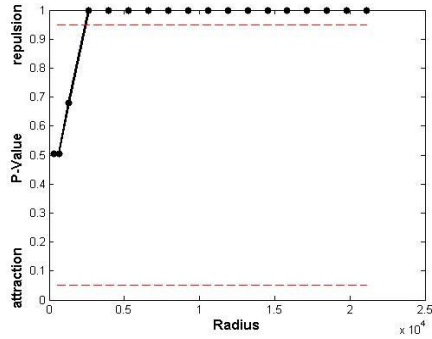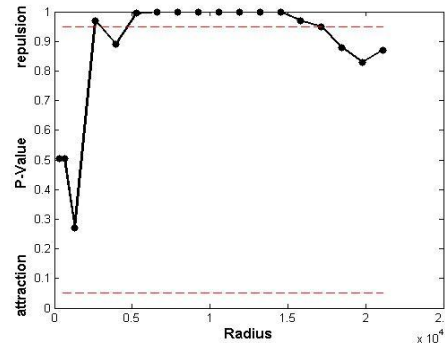

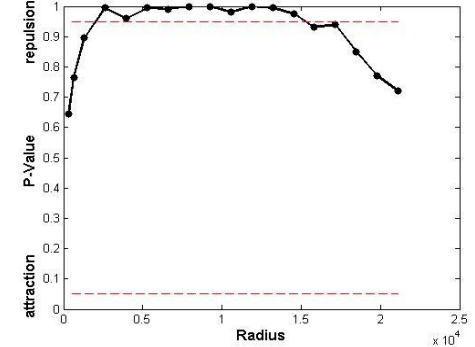**Fig. 10**: Gr. 5, 2005-06

Fig. 11: Gr. 8, 2005-06
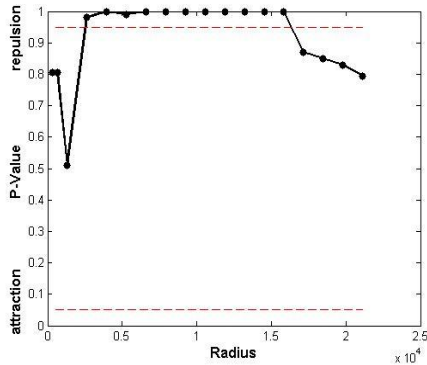

Fig. 12: Gr. 11, 2005-06

Fig. 13: Gr. 5, 2006-07
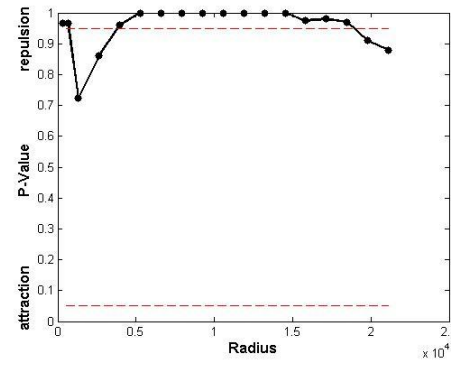
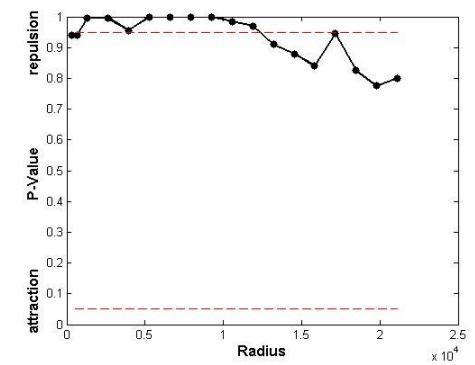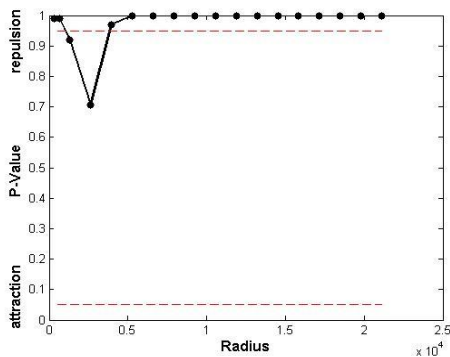**Fig. 14**: Gr. 8, 2006-07
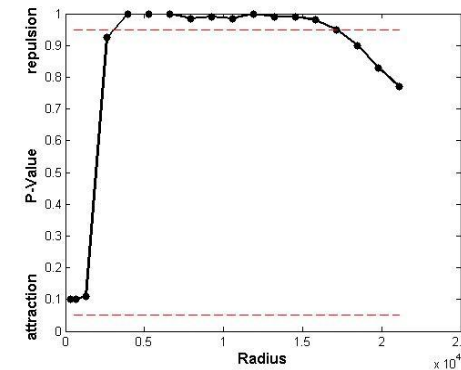

Fig. 15: Gr. 11, 2006-07
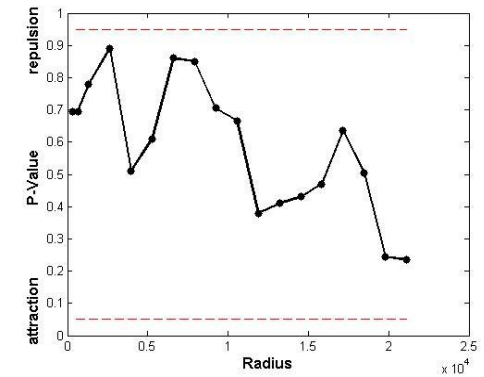

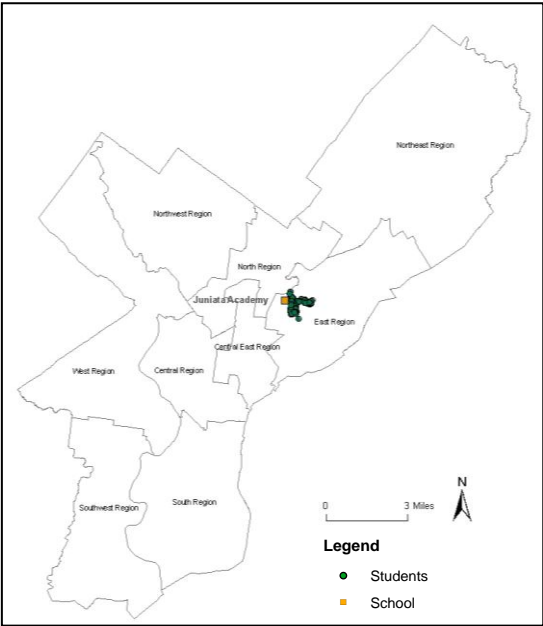**Fig. 16**: Gr. 5, 2007-08

Fig. 17: Gr. 8, 2007-08

Fig. 18: Gr. 11, 2007-08

APPENDIX C: Additional Maps and Figures

Fig. 1: Clustered Distribution of Students, Block Group/Enrollment Ratio = 0.093
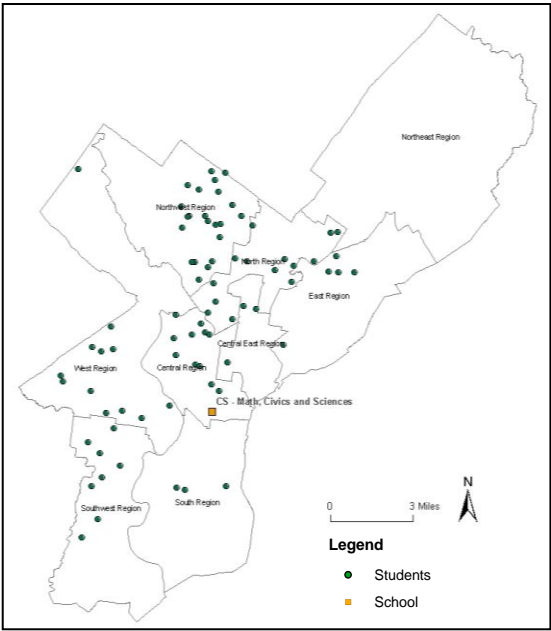
Fig. 2: Dispersed Distribution of Students, Block Group/Enrollment Ratio = 0.987
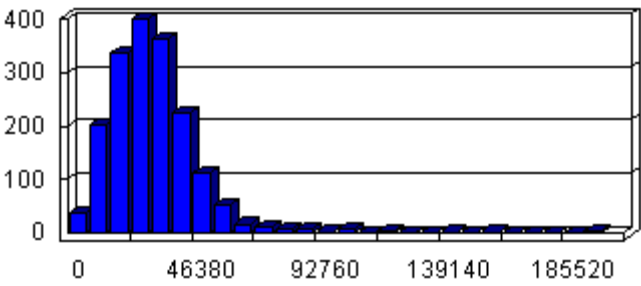
Fig. 3: Frequency Distribution, Median Household Income ($)
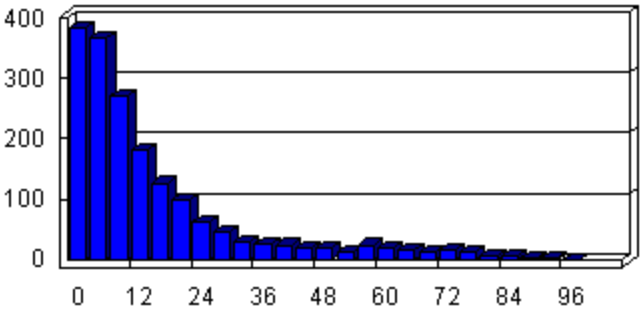
Fig. 4: Frequency Distribution, Population Holding Bachelor's or More Advanced Degree (%)
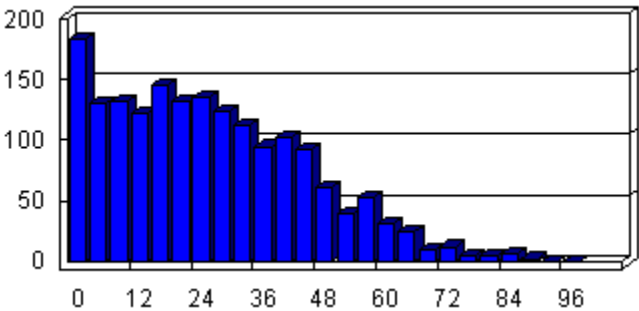
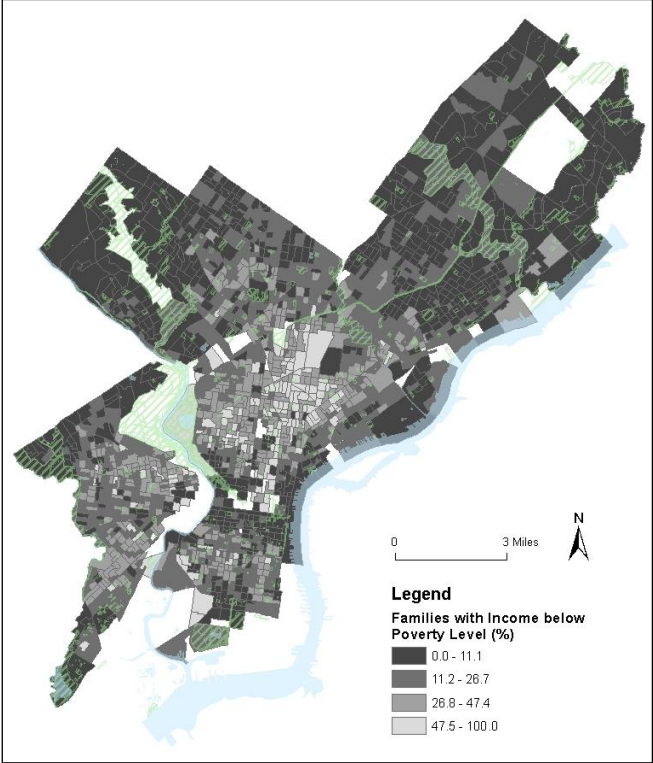**Fig. 5**: Frequency Distribution, Families with Female Head of Household with Related Children under 18 (%)
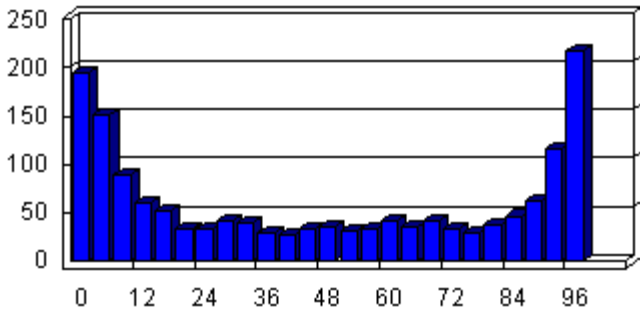
Fig. 6: Frequency Distribution, Population Non-White/Non-Asian (%)

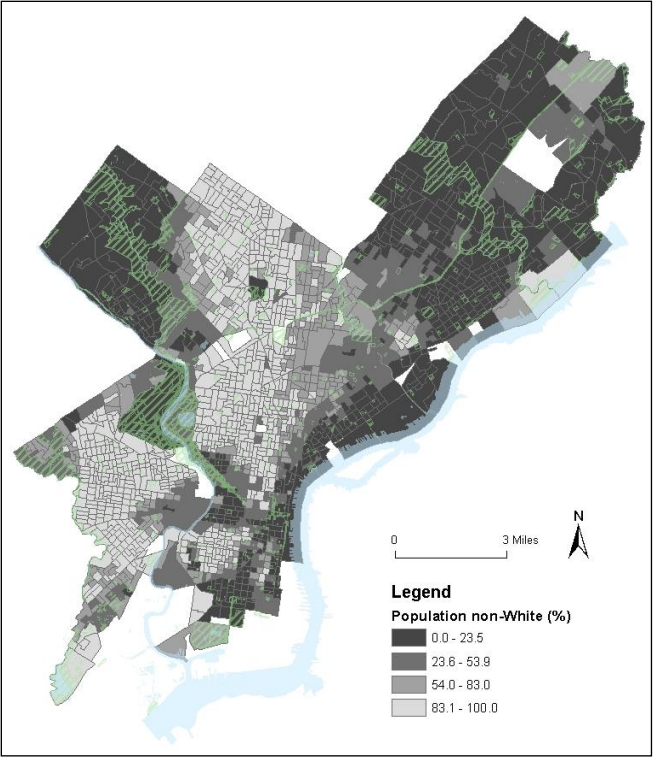Note: Distribution of demographic characteristics displayed by quartiles.
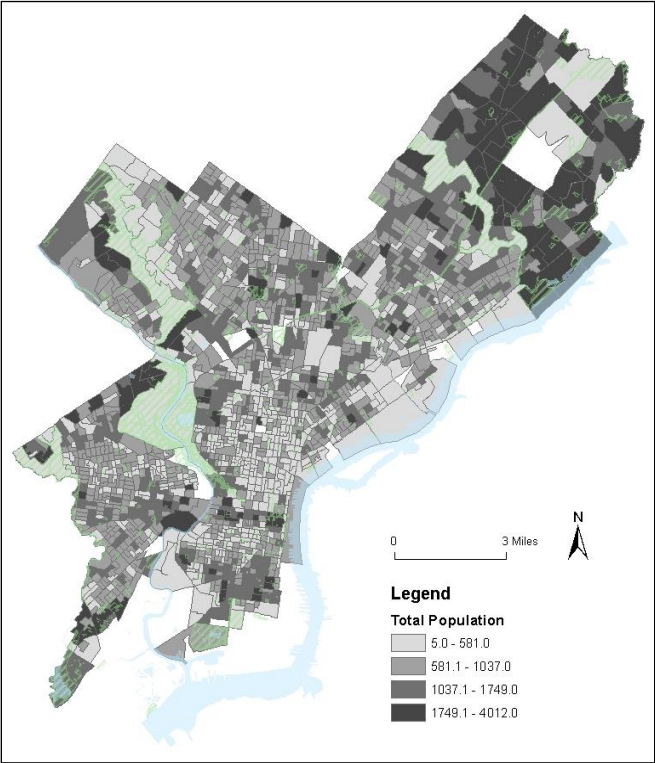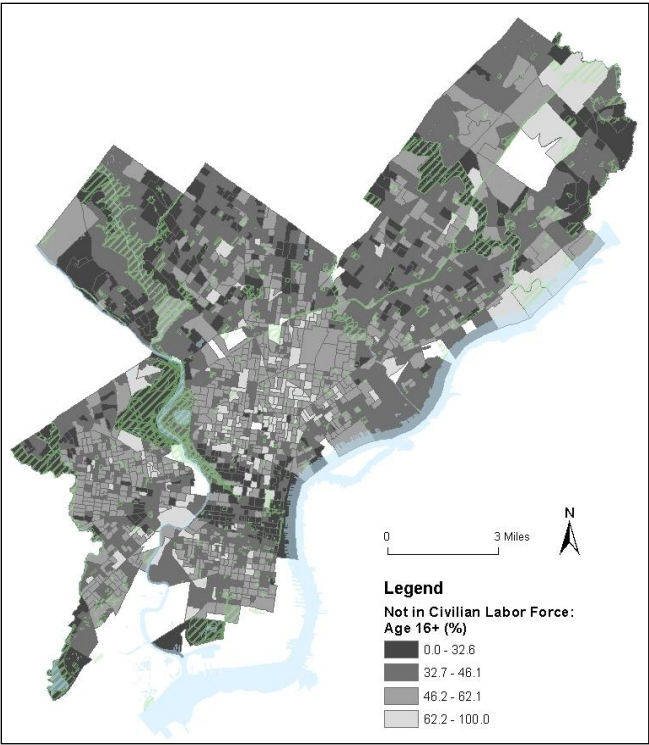

Fig. 7: Total Population by Block Group

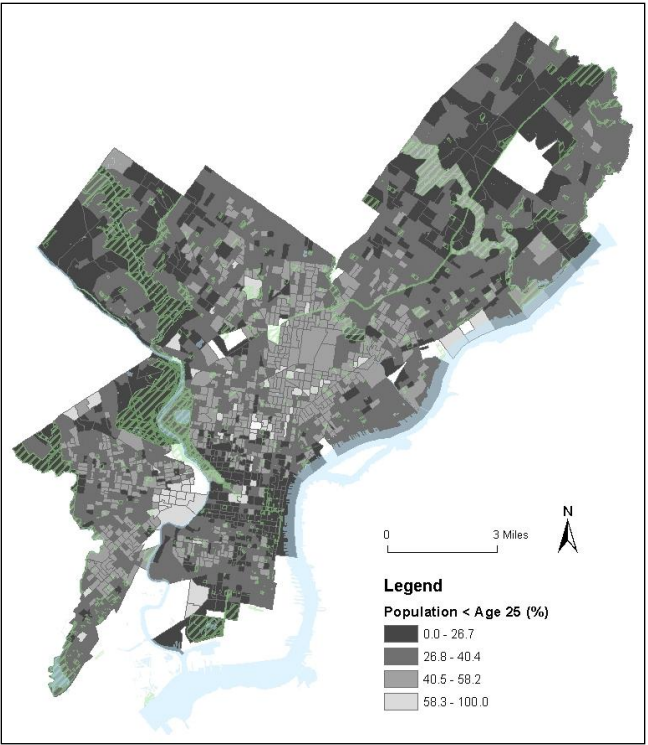**Fig. 8**: Families below Poverty Level by Block Group (%)
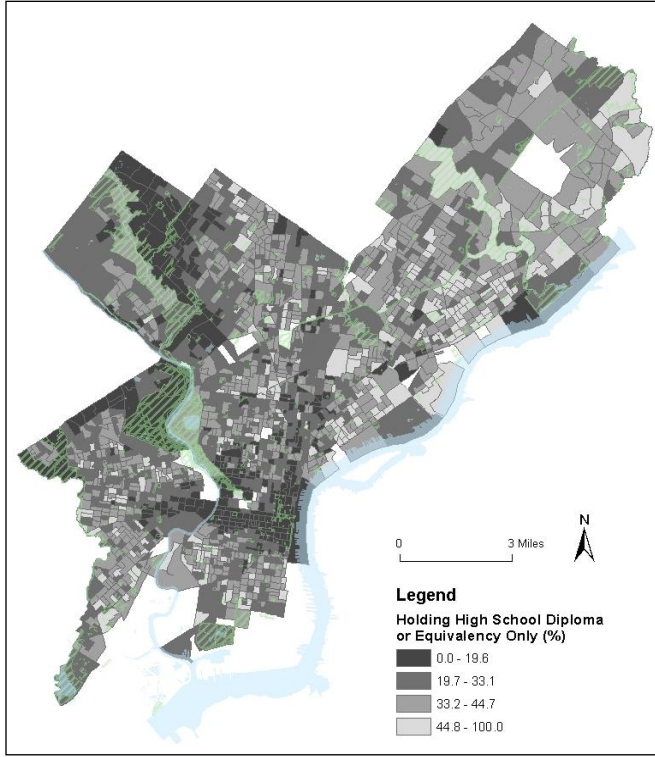
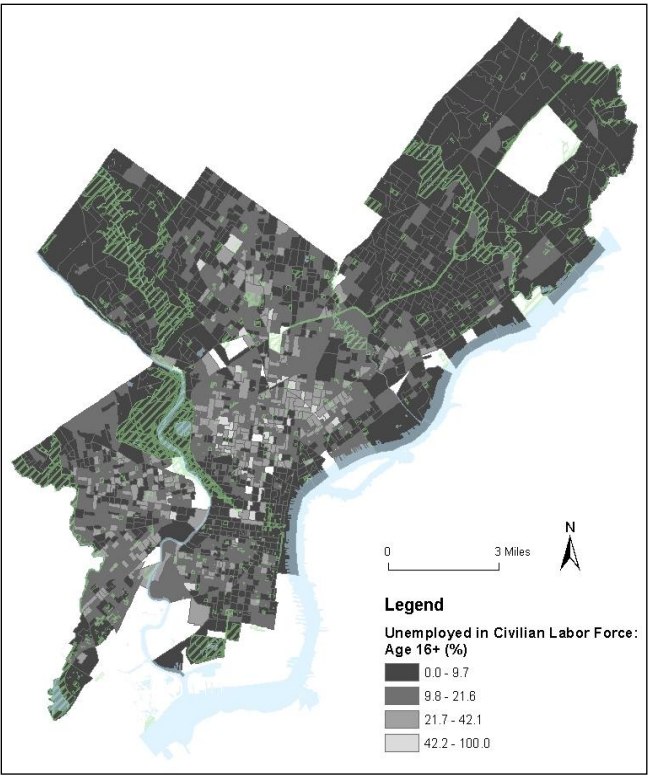**Fig. 9**: Population Holding High School Diploma or Equivalency Only by Block Group (%)

Fig. 10: Population Non-White by Block Group (%)

Fig. 11: Population Not in Labor Force by Block Group (%)

Fig. 12: Population under Age 25 by Block Group (%)

Fig. 13: Population Unemployed by Block Group (%)